

Case Study

FIRST THREE SOLAR PV INDEPENDENT POWER PRODUCERS IN SENEGAL

BACKGROUND

Since 2010, Senegal has actively pursued reform policies in the energy sector, with a strong focus on promoting renewable energy. The emphasis on renewable energy (RE) has resulted in the adoption of a Renewable Energy Law in 2010 and led to the development of various objectives including but not limited to:

- Increasing the installed renewable energy capacity to 20% of the total installed capacity by 2017
- Reducing the cost of generation and consequently the electricity tariff for households and companies
- Increasing the share of renewables in the energy mix in order to improve the energy independence of the country

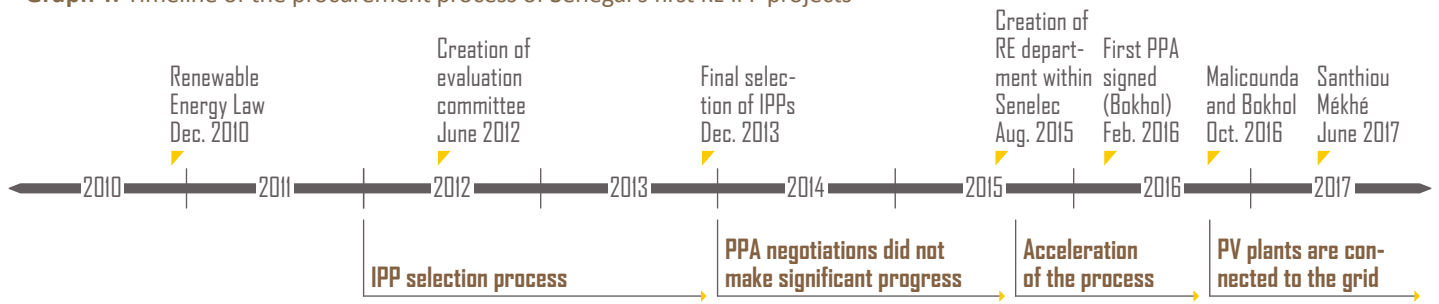
With the commissioning of three solar PV plants by independent power producers (IPPs) in late 2016 and the first half of 2017 and another three follow-up projects expected to be commissioned in the near future, Senegal is about to reach its goal of a 20% RE share in the total installed capacity by 2017 at a competitive starting price of 0.10 EUR/kWh.

KEY FACTS

| Site | BOKHOL | MALICOUNDA | SANTHIOU MÉKHÉ |
|--------------------|--|--------------------------------------|--------------------------------------|
| Installed capacity | 20 MWp | 22 MWp | 30 MWp |
| Developer | Senergy 2 | Solaria Kima | Senergy PV |
| EPC Contractor | Omexom (Vinci) | Techno Solaire | Solairedirect (Engie) |
| Inauguration | Oct. 2016 | Nov. 2016 | June 2017 |
| Investment cost | FCFA 15.7 billion EUR 23.93 million | FCFA 22 billion EUR 33.53 million | FCFA 27 billion EUR 41.15 million |
| Financing | 75% debt from single European lender | Full equity | 75% debt from single European lender |



Graph 1: Timeline of the procurement process of Senegal's first RE IPP projects



IPP SELECTION PROCESS

The Renewable Energy Law which has been enacted in December 2010 regulates the renewable energy sector in Senegal and covers, among others, tax incentives, grid access, and feed-in tariffs for the excess generation of renewable energy systems for self-consumption. Follow-up implementation decrees determine the specific incentives to promote RE.

While the law foresees that in principle RE power generation should be procured through competitive bidding, it also enabled the signing of formal direct agreements between the state-owned utility *Senelec* and IPPs during a 2-year transition period (January 2011 to December 2013). As a result, more than 120 RE project developers submitted offers to the authorities. In June 2012, an inter-ministerial committee for the selection and accreditation of utility-scale grid-connected RE projects (composed of members from the Ministry of Energy, *Senelec*, the National Renewable Energy Agency, the Rural Electrification Agency, the National Energy Efficiency Agency and the Electricity Regulatory Commission) was set up to review all the offers that had been received. The work of the committee resulted in the selection and accreditation of 72 developers

who were invited to start PPA negotiations with *Senelec*. However, *Senelec* soon became conscious of the fact that they could not conduct negotiations with 72 developers to reach a target of 262 MW by 2017.¹ Therefore, it was decided to select developers based on a simple bidding process with evaluation criteria covering technical, financial, organisational and planning aspects, but with the energy price (FCFA/kWh) being the most important and thus having the strongest weight. A letter accompanied by a questionnaire covering various aspects concerning the characteristics and the level of maturity of the project was sent to all developers on 18th July 2013, and they had one month to get back to *Senelec*.

Senelec reviewed the offers received and took the decision to retain only investors who would accept the energy price of 65 FCFA/kWh (approx. 0.10 EUR/kWh). With the annual indexation of 1.75%, this results in an average price of 80 FCFA/kWh (approx. 0.12 EUR/kWh) over the lifetime of the PPA (25 years).

¹ The 10% target was expected to correspond to 262 MW (*Senelec* 2013).

PROJECT MILESTONES



By 2011: Over 100 spontaneous applications for renewable energy IPPs (mainly solar) had been received by the Ministry of Energy



June: Selection committee is established. 72 IPPs are short-listed based on a first appraisal



31.12. Deadline to submit bids with a fixed PPA price of FCFA 65/ EUR 0.10 per kWh



January: *Senelec* invited ten IPPs to negotiate PPAs (nine solar, one wind)



August: Creation of Renewable Energy Department at *Senelec* serving as one-stop-shop for developers



June: Santhiou Mékhé plant commissioned

PROJECT DEVELOPMENT

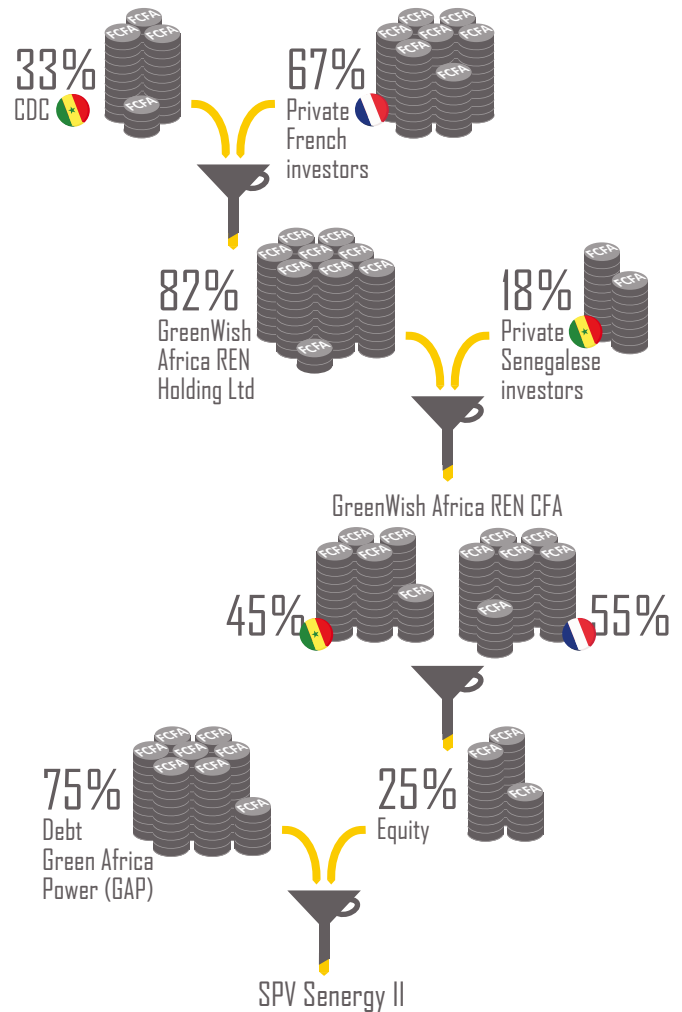
When the ten IPPs were invited to start negotiations with *Senelec* at the beginning of 2014, the PPAs were standard documents for which many project-specific amendments were requested by the sponsors and lenders. Only once the first amendments were signed by *Senelec*, the PPAs and therefore the projects became more bankable and the last phase of the development started. This phase (2015 until early 2016) included the selection and securing of suitable plots of land as well as the finalisation of studies such as the Environmental and Social Impact Assessments (ESIA). In parallel a national grid integration study covering all envisaged PV and wind plants was undertaken by *Senelec*.

BOKHOI — The Sponsor *GreenWish* acquired the rights to the Bokhol project from the original project proponent in January 2015. The final project development phase took about one year and included an ESIA financed by the African Development Bank (AfDB).² For this plant, a field of 50 ha (classified as lowest value since it was neither inhabited nor fertile) was expropriated from the municipality by the State. The developer has signed a 25-year lease for an annual fee of about of FCFA 8 million (approx. EUR 12,200) which is payable to the municipality. According to the developer, the process from the identification of the land to the signature of the lease took approximately one year.

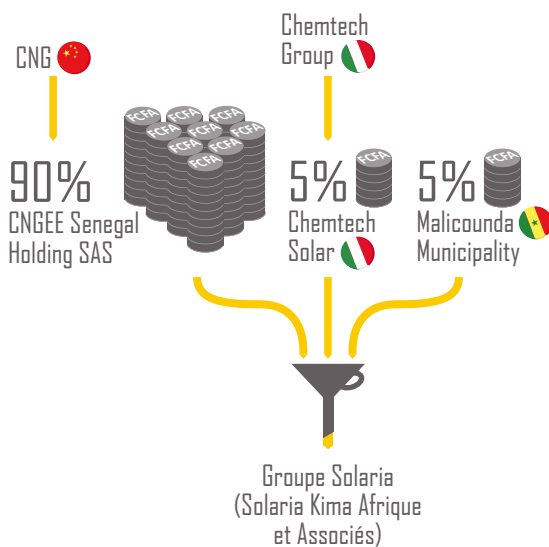
The Bokhol project structure is quite innovative in that it includes local investors and more particularly the Senegalese *Caisse des Dépôts et Consignations* (CDC) which is a public entity. CDC is under the Senegalese Ministry of Economy and Finance. However, it is financially autonomous as its budget is independent from the national budget. The participation of CDC was an important point to attract other investors. In total, 45% of the equity came from Senegal. A construction finance loan of EUR 20 million was provided by *Green Africa Power* (GAP), but *GreenWish* is planning to restructure the debt and obtain long-term senior debt from another source.

Omexom, which is part of the French *Vinci* group, was chosen as the EPC contractor.

Graph 2: Financial structure of Bokhol project



Graph 3: Financial structure of Malicounda project



MALICOUNDA — The project of Malicounda was developed by the Senegalese company *Groupe Solaria SA/Solaria Kima Afrique et Associés* with the Italian company *Chemtech Solar* as the main shareholder who financed the construction of the plant. *Techno Solaire* which is also owned by *Chemtech* developed the project and serves as the EPC contractor as well as the operator of the plant. In November 2016 90% of *Groupe Solaria* were acquired by the Chinese company *CGN Europe Energy* (CGNEE). CGNEE is a subsidiary of the state-owned *China General Nuclear Power Group* (CGN).

The PV power plant of Malicounda has been integrally financed by equity and did therefore not undergo a lengthy debt financial closing process.

² AfDB 2015.



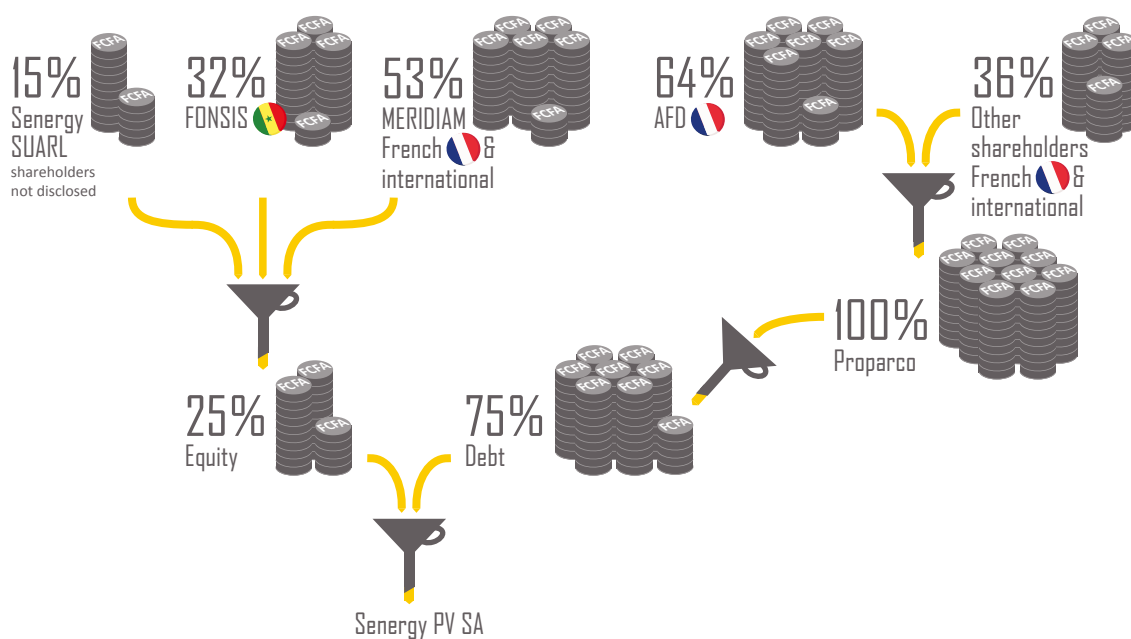
Malicounda

SANTHIOU MÉKHÉ — The Santhiou Mékhé project was originally developed by the Senegalese-born American Sam Wébé whose company *Senergy* SUARL entered into a partnership with Senegal's *Fonds Souverain d'Investissement Stratégique* (FONSIS) and the private investment company *Meridiam* in February 2015. FONSIS was created in 2012 by current President Macky Sall to promote the role of the State as an investor. As a result, this project can also be referred to as a PPP. In total at least 32% of the funds came from Senegal. The

debt came entirely from *Proparco*, the private sector financing arm of the *French Development Agency* (AFD). According to Sam Wébé, it took approx. one year to find a suitable site where the local community was interested in cooperating with the developer.³ The plant was built by *Solairedirect*, a company of the French *Engie* group.

³ Le Soleil, 05.08.2017.

Graph 4: Financial structure of Santhiou Mékhé project



TECHNICAL DESIGN AND CONSTRUCTION

All three PV plants use state-of-the-art PV and inverter technologies. Generally speaking almost all the material was imported and the IPPs have not sought to optimise local content in the choice of construction materials.

All three IPPs have preferred robustness and reliability over maximisation of yield and have selected off-the-shelf crystalline silicon modules and fixed mounting structures (as opposed to trackers).

In terms of the inverter concept, all three IPPs have selected significantly different approaches in search of the same result: high availability. It will only be possible to assess the adequacy of each

of these choices after a few years of operation. For the inverter/transformer stations of Bokhol and Santhiou Mékhé, the EPC contractors have chosen pre-cabled plug-and-play solutions. Only the developer of the Malicounda plant has maximised the use of local labour by installing string inverters (which require significantly more labour for on-site installation) and by using blockwork transformer stations constructed on site.

For the foundations of the mounting systems, all three EPC contractors have used highly modern techniques which, however, required importing adequate equipment.

Table 1: Technology choices made by the three IPPs

| | BOKHOL | MALICOUNDA | SANTHIOU MÉKHÉ |
|----------------------------|--------------------------|------------------------------|---|
| INVERTER TYPE | Outdoor cooled inverters | Outdoor string inverter | Central inverters in container stations |
| MODULE TYPE | Crystalline | Crystalline | Crystalline |
| FOUNDATION TYPE | Rammed profiles | Earth screws | Pre-drilled concrete micropiles |
| CONSTRUCTION PERIOD | 7 months | 5 months for phase 1 (11 MW) | 12 months |

OPERATION

As the operation of the plants is fully automated, little personnel for operation and maintenance is required. The IPPs announced that they created between 25 and 50 jobs for the operation and maintenance of the plants. Most of these jobs are unskilled and cover security, vegetation control and cleaning of the modules as well as the control rooms. The developers of the different projects have chosen different cleaning strategies such as using a truck with washers (Bokhol) and manual cleaning (Malicounda) using water thanks to a borehole on site.

ECONOMIC AND FINANCIAL ANALYSIS

Following the individual negotiation of the PPAs, the terms and conditions of the three PPAs are similar but not identical. For example, the PPA for the Bokhol project has a tenure of 20 years while those for Malicounda and Santhiou Mékhé have tenures of 25 years. All three PPAs are based on the take-or-pay principle, whereby *Senelec* is obliged to pay for an agreed amount of energy per year from the IPP, whether *Senelec* is able or not to offtake it (for instance because of grid unavailability or curtailment measures).

Both the starting price of 65 FCFA/kWh (0.10 EUR/kWh) and the average price of 80 FCFA/kWh (0.12 EUR/kWh) are similar to *Senelec's* average variable cost of generation which was 61 FCFA/kWh (0.09 EUR/kWh) in 2015, down from 83 FCFA/kWh (0.15 EUR/kWh) in 2013 (*Senelec* 2016). This decline is due to a significant drop of the oil price, which is projected to rise in the medium term.⁴ These costs include the cost of *Senelec's* own production, as well as purchase of power from local IPPs (around 100 FCFA/kWh), from Mali (22 FCFA/kWh) and from Mauritania (90 FCFA/kWh). The costs of *Senelec* own's production only include variable costs, the amortization of the equipment is not taken into account.

The advantage of the power purchases from the solar PV IPPs is that the price is contractually fixed and therefore predictable. In addition, Senegal is benefitting from FOREX savings because of avoided fuel imports and the reduced need to have FOREX reserves for those imports.

⁴ IEA projected the oil price to at least double from the 2015 level until 2030 both in the New Policies Scenario (countries implement all announced climate mitigation actions) and in the Current Policies Scenario (IEA 2016).

COMMUNITY RELATIONS AND SOCIO-ECONOMIC BENEFITS

For the plant of Bokhol, the village mayor (and the 27 small villages around) saw the opportunity to value an unused plot of land without any problem of resettlement. As a real novelty, the developer signed a contract with the community in order to agree on the objectives and the contributions of each party. This agreement was signed to appease the community and fix the obligations of each party, in particular the participation of the community and support for improving the local infrastructure from the developer. As a result of the negotiations, the developer agreed to electrify the surrounding villages and households with a combination of mini-grids, solar home systems and solar street lights. These costs and other »soft costs« are all included in the overall EPC price.

In Malicounda, the land for the project was acquired from the community of Malicounda. 5% »free equity« (5% of the shares were given for free) was granted to the community by the developer. Furthermore, the EPC contractor *Techno Solaire* put an important focus on using unskilled and skilled local labour for plant construction and maintenance. This included the execution of DC and LV AC cabling, inverter installation, and construction of blockwork MV stations. In addition, the developer transferred FCFA 300 million

(approx. EUR 457,000) to the municipality for the electrification of the 22 surrounding villages, which started in summer 2017, and is financing the construction of a health centre.⁵ *Solaria* also committed to make 20 ha available to the local population for agricultural production and install an irrigation system.⁶

For the Santhiou Mékhé plant, the local population has been fully integrated into the project through the organisation of public consensus-building meetings and the formation of a monitoring committee that assisted the developer among others in the recruitment of local labour. The EPC firm *Engie Solairedirect* and its numerous subcontractors⁷ employed approx. 350 people during the construction phase incl. 150 from the eight surrounding villages. They are also implementing an agricultural project on 10 ha of land which provides support to local farmers. In addition, they constructed a fully-equipped maternity and established two microcredit lines for women from the project area.

⁵ Sources: Le Soleil, 12.06.2017 and Le Soleil, 29.09.2017.

⁶ Source: Sen360.fr, 31.10.2016.

⁷ These included eight international firms and 21 firms registered in Senegal.



* Announced job creation during construction

** Free equity given to the community

EMPLOYMENT AND OTHER COMMUNITY BENEFITS



Bokhol

ENVIRONMENTAL BENEFITS

During each year of operation, the plants collectively help to avoid approx. 65,000 tons of CO₂. This figure was calculated based on the UNFCCC-approved grid emission factor for Senegal.⁸ Furthermore, the projects also help to avoid local emissions of nitrogen oxides (NO_x) and other pollutants that would have occurred if the utility had had to replace the plant's generation partly with generation from its thermal power plants. The Bokhol and Santhiou Mékhé projects are registered as Clean Development Mechanism (CDM) projects.⁹ In the case of Bokhol, the revenue from the carbon credits is expected to be given back to local communities in the form of investments in health, education and agricultural infrastructure.

⁸ Source: UNFCCC 2016.

⁹ The CDM Project Design Documents (PDD) are available at <https://cdm.unfccc.int/Projects/Validation/DB/49AN8KKVZO5SZ84NKAEGYPOBXHWQ35/view.html> (Bokhol) and <https://cdm.unfccc.int/Projects/DB/RWTUV1476177787.05/view> (Santhiou Mékhé). Santhiou Mékhé is registered as a Gold Standard CDM project.

CONCLUSIONS

The first three solar IPPs of Senegal went online in 2016/2017 and contributed significantly to the recent increase of the RE share in the electricity mix. They also helped Senegal to become the leading West African country with regard to grid-connected non-hydro RE development. It took five years from the first spontaneous applications to the commissioning of the solar power plants. This process was facilitated by a series of legal measures (laws and decrees) as well as the creation of a dedicated department at *Senelec*. The government's decision to provide sovereign guarantees to minimize the off-taker risk can be seen as a decisive factor that enabled the project developers to reach financial close and reach the operation stage.

The agreed kWh price is at the level of today's average variable cost of generation in Senegal and guarantees long-term tariff stability. Two of the plants have a relatively high share of Senegalese shareholders and were partly financed with some sort of public funds.



Santhiou Mékhé

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