



Mini-Grid Policy Toolkit-Case Study

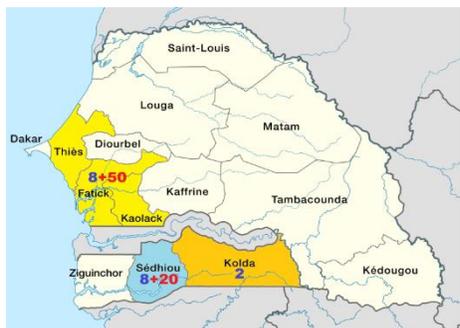


Country: **SENEGAL**

Project: **ERSEN Off-grid Solar Energy Programme**

Hybrid Utility-Private Operator Model

Project Summary



Location of ERSEN ERIL projects

The regulatory framework in Senegal promotes the electrification of remote areas where grid concessionaires do not provide electricity, which is done through rural local initiatives for which international financial support is available. Different approaches with different financial models and tariff schemes are currently applied in Senegal by different operators.

One such approach is the Renewable Energy for Senegal (ERSEN) Off-grid Solar Energy Programme. Under ERSEN, these off-grid initiatives are structured as hybrid operator models, whereby the Government remains the owner and a private firm has a concession for operation, maintenance, and repair. To date, 18 mini-grids have been implemented, powered by PV and diesel generator technologies and operated by local private businesses. Tariffs are sufficient for covering operational and maintenance costs, as well as repairs.

Other more private sector driven approaches use public subsidies only to finance the distribution grid infrastructure, whereas private investments (a mix of equity and debt) are mobilized to set up the power generation system. The tariffs applied cover operational as well as investment cost.

Background

The Senegalese Government has set a target of reaching a rural electrification rate of 62% by 2022, which means connecting 22,500 rural households every year. In order to achieve this, the Government has set up the Agence Sénégalaise pour l'Électrification Rurale (Senegalese Agency for Rural Electrification – ASER), whose mandate is to promote electrification by providing support to



local, national, and international initiatives.

One of these initiatives, the ERSEN Project, is being implemented jointly by GIZ (under its Programme for the Promotion of Renewable Energy, Rural Electrification, and Sustainable Supply of Household Fuels (PERACOD) and ASER under the guidance of the Ministry of Energy and the Development of Renewable Energies. It is financed by the Dutch-German Partnership Energising Development (EnDev) and the European Union. The ERSEN Project supports private sector concessions for the implementation of hybrid renewable energy mini-grids using solar and diesel power to provide electricity to remote areas.

The mini-grids are implemented as Local Rural Electrification Initiatives (ERIL) in line with the Government of Senegal's national electrification strategy. A total of 80% of the mini-grid investment cost is financed by GIZ, 10% is financed by customers, and 10% by the private operator.

Basic Information

Location	18 sites in the Kolda, Sédhiou, and Kaolack regions, Senegal
Project implementer	Overall program: GIZ; Individual projects: EnergieR, NSResif, SudSolar
Project date	Phase 1 (2005), Phase 2 (2009)
Beneficiaries	38,407 people connected including households, 88 schools and 88 clinics, small businesses, and community centres. Included 670 public lights.
Project cost	USD 90,000 – 100,000 per project site
Organisations involved	Equipment costs paid by GIZ PERACOD programme Installation and O&M costs paid by private developer/operator 15 year lease provided by the national rural electrification agency (ASER)

Policy & Regulatory Framework

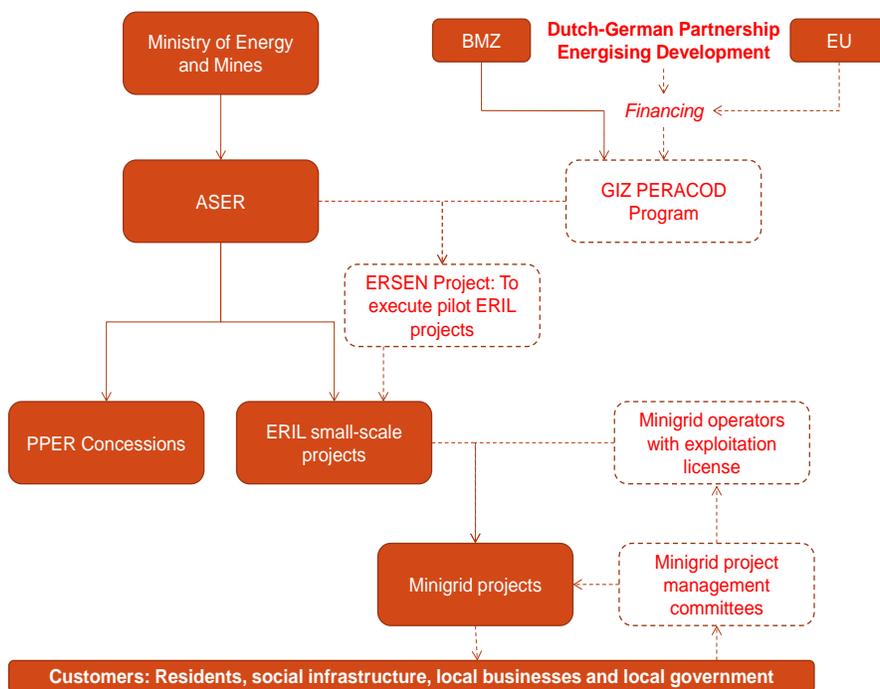
In order to meet the demand for rural electrification, ASER has been mandated by the Ministry of Energy and the Development of Renewable Energies to implement the Government's rural electrification programme, within which the following relevant items have been addressed:

- The Government has proactively provided for private sector electricity generation, in part through the establishment of large-scale concession schemes that divide the country into 10 Priority Rural Electrification Programmes (Programmes Prioritaires d'Électrification Rurale - PPER). Six out of 10 concessions have been allocated to national and international companies via tender for a period of 25 years.
- In recognising that large-scale grid extension will not meet the needs of remote off-grid communities, the Government has allowed for smaller off-grid projects in the form of mini-grids, solar home systems, and other decentralised solutions. These initiatives are termed Local Rural Electrification Initiatives (ERIL), which may be implemented by private companies, NGOs, and community groups (or a consortium thereof, as with the ERSEN project).
- A rural electrification fund (Fond d'Électrification Rurale - FER) has been established to



support the ERILs. To date, this fund has had limited use; going forward it seeks to become self-financing via a 0.7% levy on all electricity sold nationwide. This levy has been passed in law, but is not yet implemented.

- A tariff system is in place that offers predictable long-term returns, giving private sector operators a potential for up to 12% over a project life of 15 years. One third of all revenues are earmarked for deposit in an escrow account to cover the amortisation of equipment. Operators deposit funds when payments are collected, and the account controls prevent misappropriation of funds.



The institutional set-up of the ERSEN project and the mini-grid schemes implemented. Solid lines and boxes denote permanent institutions and their hierarchical relationships. Dotted lines and boxes denote project-specific relationships and activities

The above Government-set conditions constitute a package of ‘mandatory’ and ‘supporting’ policy and regulatory interventions that set a clear pathway for the development of mini-grids in Senegal. To date there has been no specific provision for the future arrival of the national grid.

Technology

Overview

The ERSEN systems utilize solar PV / hybrid AC-coupled technology. GIZ’s PERACOD programme standardised the design of the mini-grid systems as much as possible in order to ensure better quality, facilitate maintenance, and minimise technology-related problems. The design prioritised robustness and operational autonomy. Control systems are in place to manage the battery to prevent damage caused by deep discharging. Performance data on production and consumption are



logged.

Technology Approach

16 of the total 18 installed ERSEN mini-grids consist of a 5 kWp solar PV array, 10kVA diesel backup generator, and an 800Ah battery bank. The remaining two deviate from this standard set-up: one has an additional 5 kW wind turbine, and the other has a larger 13.3 kWp solar PV array without a backup generator. All systems are AC-coupled to facilitate expansion and eventual grid connection. The mini-grids supply 18-24 hours per day of electricity to households, businesses, and social institutions that were not previously electrified, with an average of 30 clients each.

Operator Model

Ownership and operations

The operator model in use for the ERSEN mini-grids is a **hybrid utility-private model**.

ERSEN's plants are owned by the government and licensed to private operators who have the right to operate the plant and sell electricity produced at regulated prices for 15 years.

Pricing and tariffs

Four consumer tariff levels are applied. Tariffs at the individual sites vary according to the costs of the respective mini-grid project. The tariff is negotiated with the national regulator (CRSE) such that the mini-grid business plan predicts an internal rate of return (IRR) of 12%. By allowing for consumer tariffs that cover investment costs, the Senegalese Government explicitly promotes the development of mini-grids.

ERIL projects within the framework of the ERSEN program have the following standardised set-up:

- Private companies, communities, NGOs, or donors apply to ASER for permission to implement an ERIL, showing proof of sufficient financing, with a 10% financial contribution to the operator company.
- ASER reviews the concept, checks that the project area is not to be electrified for at least the next 3 years under the electrification plan of the PPER (large scale) concession holder.
- The regulatory commission CRSE defines the tariffs according to a well-defined formula.

The operator receives permission for construction and a 15-year operating lease on the equipment and site which themselves remain property of the state.

Community Role

Community involvement is organised through local project management committees. These draw together a broad base of local representatives, with equal representation of men and women, including the president of the "Conseil Rural", the local energy secretary, the head of the village, and representatives of committees and groups at a local level, such as: health committees, parent-teacher associations, the women's rights group, "GPF", and the youth association.



These committees are designed to:

- Provide a forum for dialog and coordination between residents, mini-grid operating companies, and local government
- Ensure a reliable and high-quality electricity service by organising consumer interests into a vocal body
- Coordinate operational activities such as the reporting of faults and a local maintenance person
- Communicate needs and priorities of the local population so that the mini-grid operator can provide better service, for example by prioritising certain clients or times of day.
- Inform the population about the limitations of the mini-grid-supplied electricity and other important events such as scheduled outages.

Lessons Learned

- ✓ *Technological challenges* arose from lack of familiarity with mini-grid technologies. One weak point has been local capacity to operate and maintain the battery and backup generator; another has been the introduction of batteries and consumer appliances to rural areas with no capacity to manage the waste. Installation of high-end systems that are durable and require minimal maintenance can pay off. Training of on-site supervisors and technicians to operate and maintain the mini-grid is essential to long term viability. Waste management must be built in to the project/programme design from the outset, with the project owner or government taking ultimate responsibility for safe disposal or recycling of toxic parts.
- ✓ *Socio-economic challenges* arose from high (and sometimes unmet) consumer expectations, and difficulties aligning payments with customers' seasonally variable income streams. ERSEN's monthly dispatch of a technical expert from the city to deal with O&M issues created some tension from customers who demanded more from the local supervisor. Informing the community of timelines, potential problems, service conditions, and tariff policy is essential to ensuring good relations in the mini-grid's operational phase. Management committees, including customer representatives, can serve as both a conduit for such information, as well as providing a forum for the settlement of disputes over service quality or pricing.
- ✓ *Business and management challenges* arose with the public-private partnership (PPP) arrangements, such as the sharing and management of investments, revenue, and responsibilities between private and government partners, and low technical capacities. More generally, the consumer tariff scheme was being tested in a uniquely challenging environment, in which people had gained access to grid electricity for the first time. Load and energy limiters should be in place at the point of project commissioning. Customers will quickly become accustomed to higher service levels and will resist reductions in that service, even if previously forewarned. Customers tend to compare electricity tariffs with those of the national grid. As a result, even remote mini-grids need to consider national grid electricity as a competitor; if tariffs are significantly higher than those of the grid, customers may resist payment even if it results in disconnection. Residential customers are relatively insensitive to power outages, especially if scheduled. Many of the ERSEN project sites allow



for scheduled outages in the morning hours between 2:00am and 10:00am.

- ✓ It is worth considering Senegal's ERIL approach as a model for rural electrification. It involves a strong governmental role in investment subsidies and price controls, with flexibility in the setting of different subsidy levels. Challenges to this include a high up-front subsidy required, low absolute revenue to the operator due to the small size of projects and the low electricity price, and a weakened sense of ownership of installation equipment as a result of the investment subsidy and the power plant remaining the property of the state at all times.
- ✓ Overall it was seen that, large up-front subsidies are unsustainable, and governments and donors should plan for a withdrawal of public intervention in investment-stage activities such as equipment purchasing. Governments should shift from a project-by-project to a programmatic approach, which would enable economies of scale. This could involve increasing standardisation in the project approach, integration of the financial sector, and the reduction or elimination of the investment subsidy. And that, an operational and well-funded Rural Energy Fund can be a proactive vehicle for mini-grid promotion.
- ✓ Regulatory challenges related to balancing public and private sector intervention, and to keeping rural electricity affordable have been found. Potential ways to address these can include: Transferring increasing levels of responsibility of overall programme management from GIZ (and other donors) to ASER and the local government. Developing human resource capacities in ASER, private companies, and local government institutions in the fields of renewable energy and mini-grids. An energy regime characterised by low levels of bureaucracy and overt government support for private ownership of energy infrastructure is key to mini-grid development