Mini-Grid Policy Toolkit – Case Study

Country: CAPE VERDE

Project: Monte Trigo Solar PV Mini-grid

Hybrid Operator Model

Project Summary

Monte Trigo, Cape Verde
(Source: Trama TecnoAmbiental)

A 100% photovoltaic (PV) system with integrated storage was installed in an isolated village on an island to supply electricity to all households and businesses which pay a fee for the use of electricity. The previously used diesel generator remains available for backup. The satisfied clients are able to cope with the limited electricity supply thanks in part to the intelligent EDA (Energy Daily Allowance) concept, which allows flexible management of kWh. Operation is a hybrid of public and private inputs, whereby the municipality has invested 25% and the rest was a donation through the ACP-EU Energy Facility. Operation and maintenance (O&M) are the responsibility of the private local water company. As long as the Government of Cape Verde has not established a national framework for off-grid electricity tariffs or endorsed the one calculated by the promoter for this mini-grid, users will continue to pay the same amount they paid prior to the operationalisation of the project. Collected revenues pay for O&M, but not for the initial investments required for equipment or for their replacement, thus posing a serious threat to the sustainability of the system. At USD 4,518 per connection, this energy supply arrangement is not cheap. Thanks to the recent expansion of the PV system, new connections have been completed. The current situation is: 75 households, 4 public institutions and 4 commercial customers for a total of 83 connections.

Background

Monte Trigo is a remote village located on the south west coast of Santo Antão island in Cape Verde. It has approximately 450 residents whose income comes mainly from fishing. Prior to the operationalisation of the project the residents had been relying on a diesel generator to cover their electricity needs. This solution was costly, particularly because fuel was difficult to transport to the island, especially to the village. The diesel generator of 20 kVA was working 5 hours daily between 6 and 11 pm. This did not allow the fishermen to preserve their fish, but instead, the catch had to be

dried.

In response to this situation, the local private water company and the local municipality came together to facilitate the conversion of the existing diesel-based system into a solar PV mini-grid based on nearly 100% PV production, with financing from the Energy Facility of the ACP-EU Programme, and the 20 kVA diesel generator now functions as a backup. One of the most positive impacts of this project is the installation of two ice making machines, which allow fish to be preserved without having to dry it: fresh fish can be sold at a higher price than dried fish.

Basic Information

Location	Monte Trigo, Cape Verde
Project implementer	Constructed by Águas de Porto Novo (APN), Trama Tecno Ambiental, Erhtec, IDMEC-IST, and Transénérgie Management, operation and maintenance by Águas de Porto Novo (mixed company created by APP and the municipality) Ownership of assets: The non-movable assets (battery/ inverter room, control room, and the rehabilitated distribution network) property is of the municipality. The movable assets (solar PV modules, batteries, electronic equipment, and smart meters) property is of APN.
Project date	Starting date: 2007; beginning of operation: 2012; extension up to 40 kWp PV: 2014
Beneficiaries	450 residents of an island only accessible by boat
Project cost	USD 375,000 75 % of funding was donated by the ACP-EU Energy Facility and 25% was investmented by the local municipality (Municipality of Porto Novo)
Organisations involved	Águas de Ponta Preta (APP), Municipality of Porto Novo, Águas de Porto Novo (APN), Trama Tecno Ambiental, Erhtec, IDMEC-IST, Transénérgie Águas de Porto Novo (mixed company created by APP and the municipality) is responsible for O&M

Policy & Regulatory Framework

As an ECOWAS member state and under the ECOWAS Regional Energy Policy (EREP), Cape Verde has committed to promote increased use of renewable energy as part of the region's long-term objective of achieving universal access to sustainable energy services by 2030.

The 2008 Cape Verde National Energy Policy outlines a long-term vision of "a future independent of fossil fuels", made possible through investment in and adoption of renewable energy and alternative technologies. In 2013, 92% of the country had access to electricity, only 20% of which was generated by renewable energy. The policy targets have progressively become more ambitious and the National Renewable Energy Action Plan and the SE4All Action Agenda, adopted in 2015, set the goal of universal access to electricity, produced 100% from renewable energy resources, by 2020.

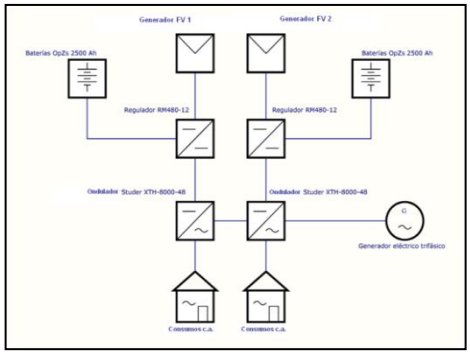
Access to electricity for the estimated 3,000 families still lacking this service will be achieved through connection to the grid where technically and economically possible, through renewable energy isolated grids, and through renewable energy stand-alone systems when there are no other feasible options.

In line with its goal of 100% renewable energy generation for its electricity, the Government of Cape Verde has chosen to exclusively promote micro-grids based 100% on renewable energy with a special emphasis on their financial sustainability and the promotion of management systems capable of guaranteeing the operation, maintenance, and renovation of the infrastructures.

To achieve these ambitious goals, public-private-partnerships (PPP) will be promoted, involving government, municipalities, civil society organizations, and the private sector. To facilitate private investment in micro-grids, innovative strategies, such as the promotion of investments of Cape Verdean emigrants, will be sought alongside adequate financial mechanisms in partnership with the national bank and international partners.

Cape Verde has progressively expanded its commitment to renewable energy production over the last decade and has established several mandatory guidelines. A 2006 law on Independent Power Production lays out guidelines and investor protections for private generation. Helpful measures were instated as well, and as of 2007, renewable energy production equipment is exempt from import duties. A 2011 Decree on the Promotion and Incentive for the Use of Renewable Energy created a Renewable Energy Master Plan, including further tax incentives, 15-year Power Purchase Agreements (PPAs) for Independent Power Producers (IPPs), and specific incentives for micro-generation and decentralized rural electrification such as the exemption from environmental impact assessment and additional fiscal incentives.

Technology



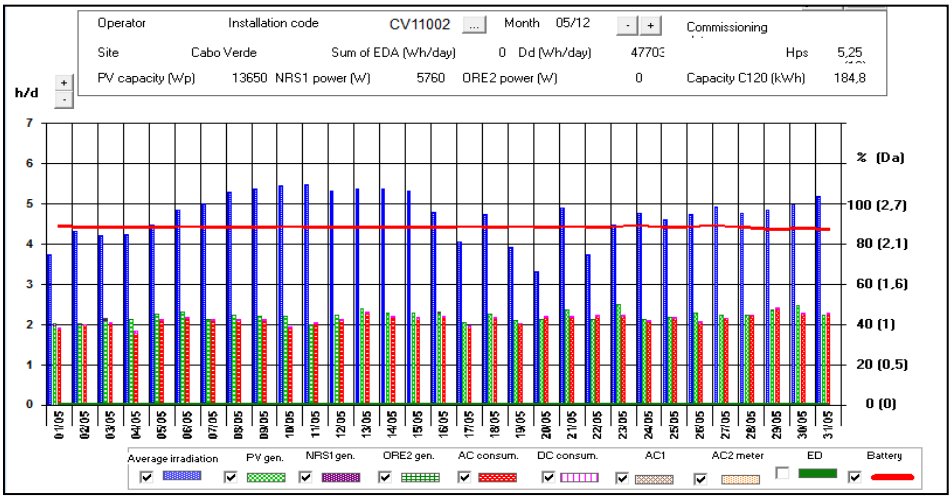
Monte Trigo PV system design
(Source: Trama TecnoAmbienta)

The facility installed in Monte Trigo is a **solar PV** mini-grid based on a PV generator, storage battery, electricity monitoring, control and power conversion equipment, and an LV distribution grid. The 40 kWp generator is mounted on a wooden pergola that provides shade to the village schoolyard and

therefore adds further value to the community.

The total installed capacity of the system is 40 kWp, with annual energy production just over 45,400 kWh. It utilizes 307 solar PV modules rated at 130Wp each in a double DC-bus 48 VDC configuration; an MPPT charge controller; a storage capacity of approximately 370 kWh in two lead acid deep discharge OPzS batteries that can provide at least four days of autonomy at the rated demand; and two dual inverters, with a rated power of 8,000 kVA (30 minutes) each, which convert the DC into single-phase 230V, 50Hz AC for distribution via an 800m aerial distribution line. Electricity is monitored online hourly. The 20 kVA diesel generator can be used as a backup.

The battery state of charge is typically between 80 and 100%. The PR has consistently been in the range of 40 to 75%, which is high for autonomous plants.



System performance of the Monte Trigo PV-diesel grid
(Source: Trama TecnoAmbiental)

Operator Model

Ownership and operations

The Monte Trigo mini-grid is set up as a public-private hybrid model, in which the local municipality and water company are directly responsible for the management, operation and maintenance (O&M) of the facility through a mixed company they have created (APN).

The mini-grid provides 24-hour electricity to 75 households, 4 small shops and businesses, a school, a medical centre, a kindergarten, as well as public street lighting. O&M activities are organized so as to involve local users as caretakers and fee collectors. APN employs specialized technicians.

Pricing and tariffs

Electricity tariffs were designed as fixed monthly rates based on an Energy Daily Allowance (EDA) and established in several tiers (USD 11 to 40) based on the local population's payment capacity. Users were supposed to pay a flat monthly fee for a pre-agreed amount of electricity.

The EDA concept, developed by the Spanish firm Trama Tecnoambiental, enabled the project developers to design the system more appropriately for present and future needs of the village. The EDA helps in making the demand side management more intelligent and flexible by limiting the power (kW) and energy (kWh/day) available to each user to an agreed maximum, while allowing some flexibility in the form of "virtual storage", or a "banking" of unused energy credit for use at another time. The residents were receptive to this usage concept, and several months after commissioning, the consumption habits of users were still aligned with the PV generation and battery capacity.

INDIVIDUAL LOAD (ENERGY DAILY ALLOWANCE)	NUMBER OF INDIVIDUAL UNITS
HOUSEHOLD (EDA-825 W/DAY)	20
HOUSEHOLD (EDA-1100 WH/DAY)	18
HOUSEHOLD/SHOPS (EDA-1650 WH/DAY)	14
HOUSEHOLD/SHOPS (EDA-2200 WH/DAY)	6
SCHOOL (EDA-1650 WH/DAY)	1
ICE MACHINE (EDA-4200 WH/DAY) DEFERRABLE	1

Breakdown of Individual Power Allowances

The estimated monthly revenue was roughly USD 1,200 , sufficient to pay for O&M costs as well as replacements, but not for the investment costs of the equipment. The simple payback time (project costs divided by revenue) was 26 years, not taking into account the repayment of the initial investment. With a grant covering 75% of the investment cost, the kWh price is approximately USD 0.58.

In the absence of a national framework for off-grid electricity tariffs, the calculated tariff scheme was agreed with the users and submitted by the project promoters to the national economic regulation authority, but has not yet been approved. Consequently, the calculated tariffs have not yet been applied and users are paying the same amount they paid prior to the operationalization of the project and revenue collected pays for O&M, but not for the initial investments for equipment or for their replacement, thus posing a serious threat to the system sustainability.

The Ministry of Tourism, Investment and Development and the economic regulation authority are currently involved in a process aiming to clarify the mini-grids tariff framework for this project and for the other systems to be promoted in future.

Lessons Learned

- ✓ The project demonstrates the feasibility of clean-energy mini-grids in Cape Verde, the first installation of this type in the archipelago, and shows the importance these systems can have in achieving the national target of universal electricity access by 2020 in remote and isolated communities.
- ✓ Nevertheless, it has also revealed to the Government and other stakeholders the challenges associated with the management, operation and maintenance of this type of system, as well as the relatively higher price of this solution compared with the national grid.
- ✓ From the policy perspective, although incentive schemes for renewable energy and decentralized systems have been established, a required regulatory and legislative framework to guarantee the sustainability of the existing systems and to promote, as foreseen in the national plans, the desired private investment in mini-grids is not yet in place. The Government is currently working on a political decision on the tariff approach, complemented by the establishment of the corresponding regulatory framework.
- ✓ This case study indicates the technical strengths of the EDA concept and, in particular, its demand-based design and scalability, which can serve as an example for similar and larger-scale deployment of PV mini-grids. Use of an EDA mechanism can help to mitigate the potential impact of rising and falling payment capacities on the part of the local users. With the addition of an electricity dispenser meter that manages the EDA for each user, batteries were always charged and the inverters always operating within the rated range.
- ✓ Training of consumers on the particular design and demands of a PV system is essential, especially if a mechanism such as EDA is to be used. Consumers were trained to understand how the electricity dispenser meter worked and to follow the guidelines on using a PV based electricity service. Practical demonstrations were also performed, directly involving the users, who responded enthusiastically. Within a few months of service, users adapted their consumption to energy availability.
- ✓ The management, operation and maintenance arrangement based on the public-private hybrid model is also an interesting aspect of this project.
- ✓ The provision of electricity to power productive uses, particularly two ice making machines in this case, has a positive impact on the users' income and also increases the revenue of the systems, thus promoting system sustainability. In Monte Trigo, these machines have been designed as deferrable loads and ice is automatically produced when excess electricity is available, reducing the cost of production and increasing the performance of the system.