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Demonstration PV rural micro grid in the island of Santo Antão (Cape Verde, Africa) with an individual energy daily allowance (EDA)

Purpose

The objective has been to electrify a fishermen's village of the island Santo Antão, Monte Trigo (pop.: 600) with a Multi user Solar Micro grid (MSG) supplying 61 connections. Implementation was in 2011 as part of the ACP-EU Energy Facility programme. Access to affordable electricity is important for basic needs (lighting and communication) but also for food refrigeration, producing ice for the conservation of the fish catch and community services.

Methodology

Objective:

- Defined ownership and responsibility
- 24h access to electricity for households and services at standard AC.
- Improve the social and economic development of the target groups by providing affordable energy services for lighting, small appliances and conservation of fish.
- Introduce and validate the concept of Energy Daily Allowance (EDA).

Approach:

To build up from state of the art and past experiences of RE rural micro grid electrification.

EDA Concept

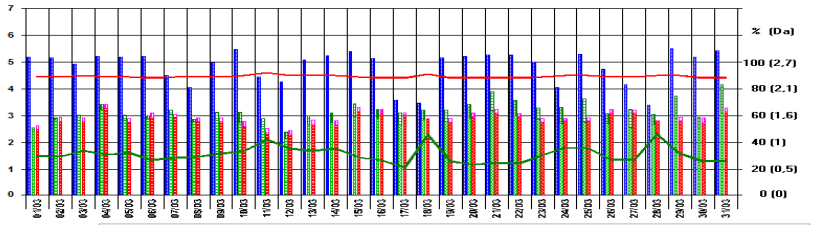
Principles:

- Measurement of the total energy consumed
- Limitation of the available energy based on the tariff contracted, with disconnection.
- Limitation of power with disconnection.
- Indicators and user advice.
- Adaptation of operation algorithm to the state of charge of the battery: The bonus mode and restriction mode encourages adequate user load management.

Technology

PV rural micro-grid with back up genset and 61 connections (27,3 kWp, 369,6 kWh storage, 16 kVA inverter).
Aggregate demand of the village capped by establishing a daily energy allowance.

Dispenser meter is mandatory in order to manage each single user electricity consumption as well as to guide user to consume in a sustainable and flexible way.



MSG MONTE TRIGO	
GENERAL SPECIFICATIONS	
Owner	Municipality of Santo Antão
Operator	APP
Quality of the service	24 h/day, 230 VAC single phase
Number of connections (initial/planned)	61 / 80
Type de Tariff	Energy Daily Allowance (EDA)
Aggregate contracted de EDA (kWh/day)	90
Rated RE Production (kWh/day – H_{pi})	142 a 5,2
INDIVIDUAL LOADS (ENERGY DAILY ALLOWANCE)	
Households (EDA=825 Wh/day)	20
Households (EDA=1 100 Wh/day)	18
Households/Shops (EDA=1 650 Wh/day)	14
Households/Shops (2 200 Wh/dia)	6
School (EDA=1 650 Wh/día)	1
ICE machine (~ 4.200 Wh/day)- deferrable	1
PV GENERATOR	
Photovoltaic Capacity (STC)	27 300 W
module Type	ATERSA 130 W_{STC}, 36 cells mono crystalline Si
Number of modules	210
Inclination / orientation	15º / +20º S
BATTERY CHARGE CONTROLLER	
Rated power	12 x 2 000 W
Converter type	Maximum power point tracker (MPPT)
Recharge algorithm	3 stage with adaptative voltage
BACK UP GENSET	
Rated Capacity	20 kVA 3 phase
Fuel	Gasoil
BATTERY	
Technology	Lead-acid vented deep discharge cycle
Number of cells (voltage)	2 batteries of 24 cells (2V ea.) (48V)
Model	Exide OPzS Solar 3 850 Ah
Total capacity (C_{100}) (kWh)	370
Autonomy	4 days at rated demand
INVERTER	
Voltage in/out	48 V_{CC} / 230 V_{AC} single phase
Rated Power (30')	2 X 8 000 W
Harmonic Distortion	< 2,5%
DATA LOGGING	
Type of data	Energy, voltage, temperature, solar radiation, etc.
ELECTRICITY DISPENSER METER	
Voltage	230 V_{AC} 50 Hz
Model	CIRCUTOR Electricity Dispenser BII
Cut off power	Setting according to tariff at (500 W,1000 W, etc)
Algorithm	Energy Daily Allowance (EDA) configurable
DISTRIBUTION and STREET LIGHTS FEEDER	
Length (m)	800
Number of lamps	20
Type	70 W hps / 2 level electronic ballast

Highlights

International cooperation: Cabo Verde, Spain, Portugal, France.

Other relevant aspects can be highlighted:

- The PV plant oversized 20% for demand growth.
- PV generator on a wooden pergola that provides shade to the village's schoolyard for added value to the community.
- The existence of a genset in the village feeding a 3 phase distribution grid that supplies only single phase loads had to be combined with a single phase PV plant concept.
- Tariff collection is based on fixed monthly rates related to EDA.
- Real time pricing broadcast (Modbus) signal encourages consumption during periods of surplus solar generation.

Conclusions

- Advantage of rural PV micro grids for the electrification of rural villages dual systems.
- O&M costs saved 10.500€/year (1st year). Users have adapted their energy consumption to the state of the PV plant and started to purchase efficient appliances.
- EDA concept and the associated tariff concept are an advantage from the social point of view but also technical and economical.
- Business model permits the operator to maintain the service during life-cycle as well as to recover O&M costs plus 25% of initial capital cost.