



Village electrification in Africa using PV Mini-Grids

A case study from Senegal

OFF-GRID POWER FORUM / INTERSOLAR, BSW, June 11th, 2015

- SOLAR23 is a provider of turnkey, grid-connected and off-grid PV systems
- Cooperates with an international network of 30 dealers and partners in over 25 countries in Europe and Africa
- Specialized in independent power supply units for:
 - telecom transmission stations
 - rural electrification of villages
 - street lights
 - water pumps for drinking water and
 - basic household electrification
- Additionally to residential and industrial customers, SOLAR23 also services national, bilateral and international non-governmental organizations (NGOs)

SOLAR23 product range



SOLAR23 offers the whole range starting from the initial consulting , planning, economic analysis, project design to the point of turnkey delivery, installation, service & maintenance. As system provider we can offer solutions for various needs with customized services.



ON-GRID



OFF-GRID



WATER PUMPING



STREET LIGHTING



PV POWER PLANT



CORROSION PROTECTION



TELECOM POWER SUPPLY



SOLAR THERMAL

Delivered markets

AFRICA

- ABIDJAN, Ivory Coast
- ACCRA, Ghana
- ADDIS ABABA, Ethiopia
- ALGIER, Algeria
- ANTANANARIVO, Madagascar
- ASMARA, Eritrea
- BUJUMBURA, Burundi
- DAKAR, Senegal
- JEDDAH, Saudi Arabia
- RIADH, Saudi Arabia
- JOHANNESBURG, South Africa
- KAMPALA, Uganda
- KINSHASA, Dem. Rep. Of Congo
- LAGOS, Nigeria
- LOMÉ, Togo
- LUSAKA, Zambia

AFRICA

- LUSAKA, Zambia
- N´DJAMENA, Chad
- NOUAKCHOTT, Mauretania
- OUAGADOUGOU, Burkina Faso
- TUNIS, Tunisia
- YAOUNDÉ, Cameroon

EUROPE

- ULM, Germany
- BORDEAUX, France

ASIA

- NEW DELHI, India
- KONYA, Turkey



Reference customers



From the beginning, our commitment to the solar industry was characterized by creativity, quality, reliability and fairness.

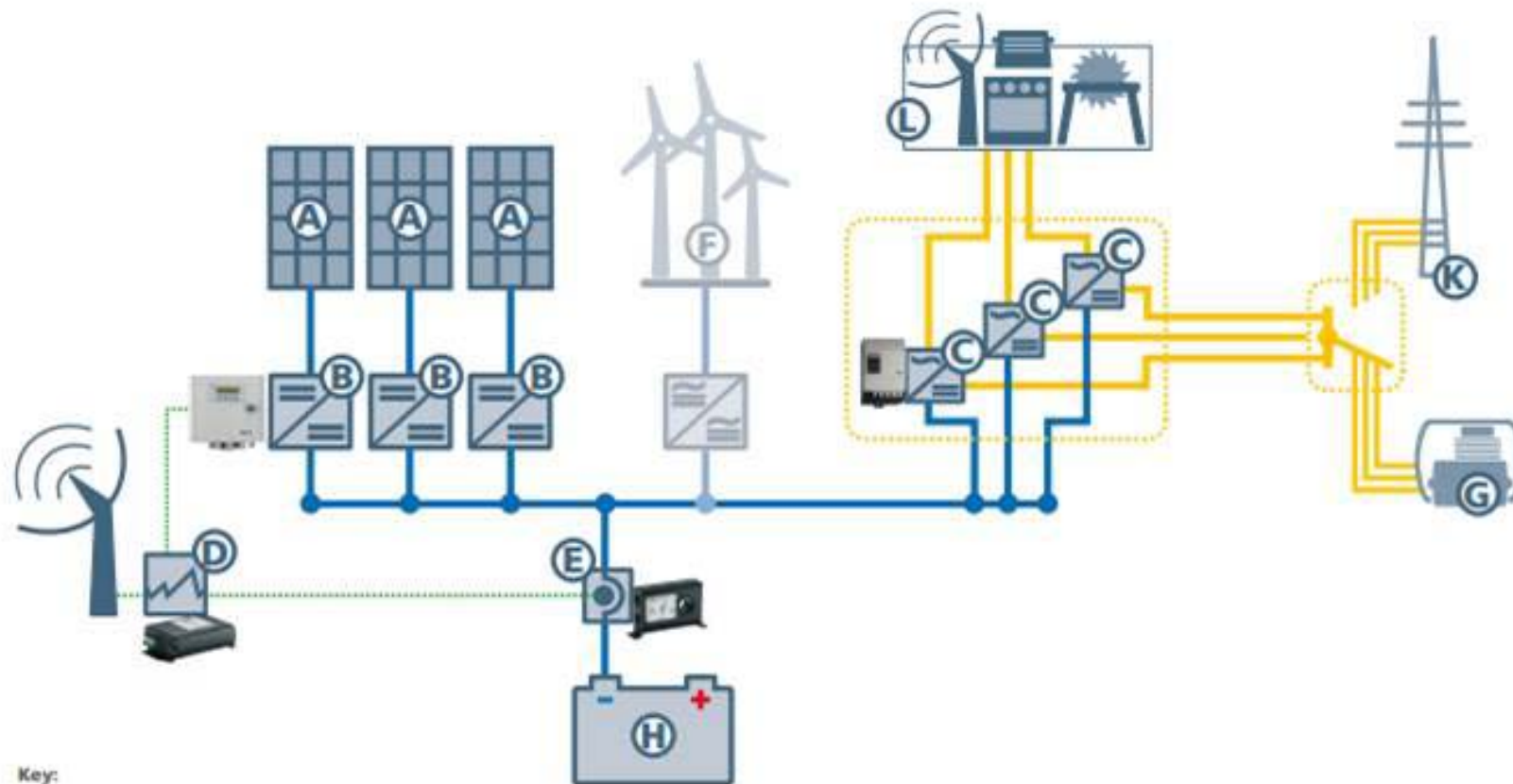
Today we are a leading partner for rural electrification and developing high efficiency solar systems for private and commercial customers as well as for institutional clients and utilities.



Suppliers pool



DC mini-grid with DC bus system



Key:

- A Solar modules
- B Solar charge controller Steca Power Tarom
- C 3 Hybrid inverters
Steca Xtender (XTS, XTM, XTH)
- D Data logger Steca PA Tarcom
- E Current sensor (shunt) Steca PA HS200
- F Wind turbines with inverter
- G Diesel generator
- H Battery
- K Public grid
- L Electrical load (400 V AC)

Advantages of DC coupling

- Easy to expand to 25 kWp
- High reliability due to redundant & modular system design
- Right choice for dominantly nighttime use

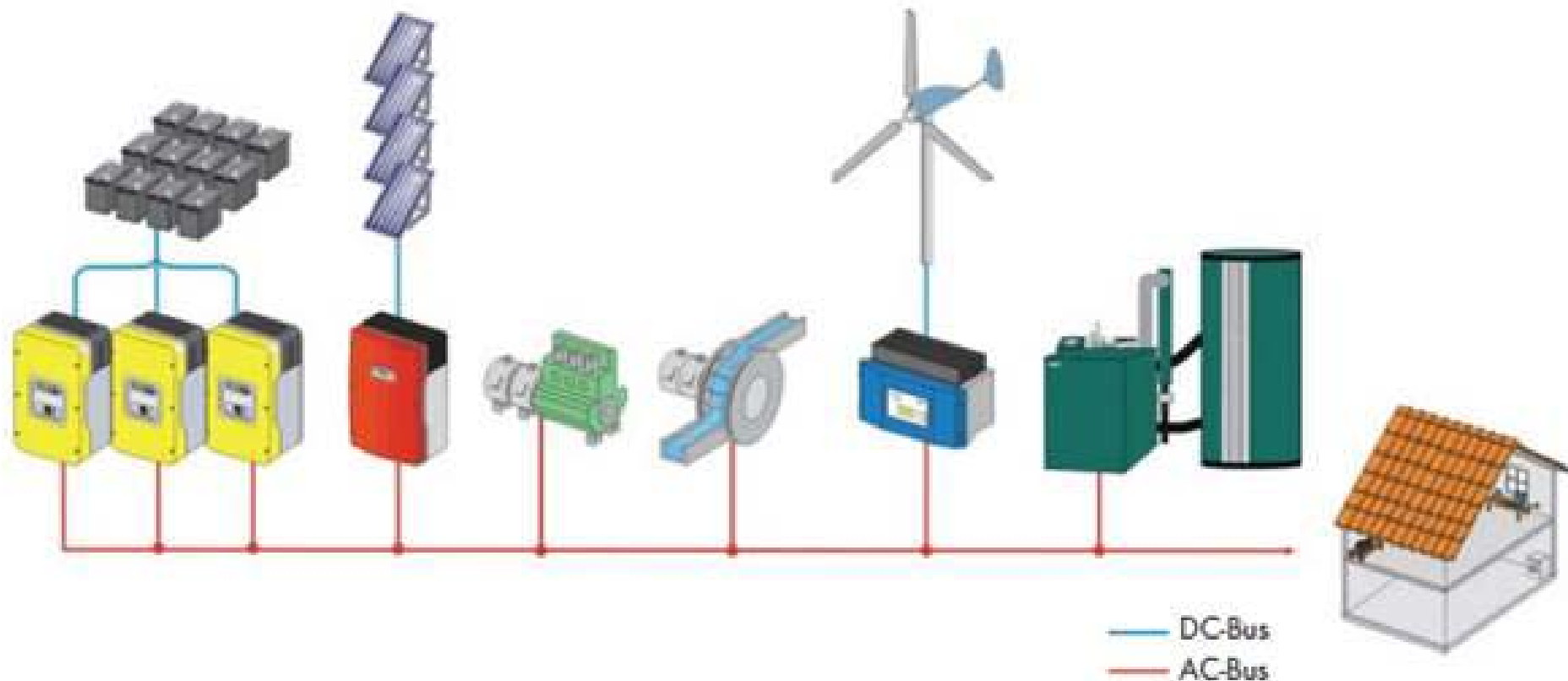
Disadvantages of DC coupling

- Parallel connection of battery banks not recommended
- Centralized installation point necessary for generators



source: STECA

AC mini-grid with AC bus system



source: SMA

Advantages of AC coupling

- Long distance distribution of 3 phase AC electricity into villages
- Compatible to public grid
- Easy to expand to 100kWp and 1MWp
- High reliability due to modular & redundant system design
- High efficiency during daytime use

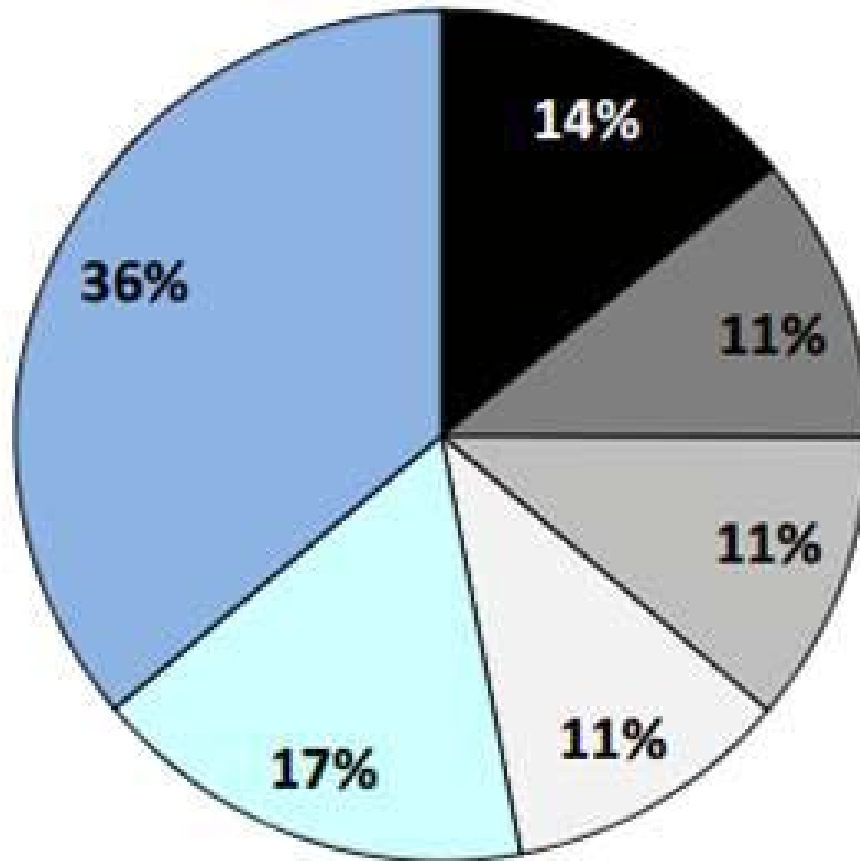
Disadvantages of AC coupling

- Conversion losses of up to 15%



source: SMA

Financial analysis: Cost break down



- solar modules & ground mount
- inverters & electronics
- industrial batteries
- logistics & installation
- civil works
- electricity grid / mains

source: SNV Niger

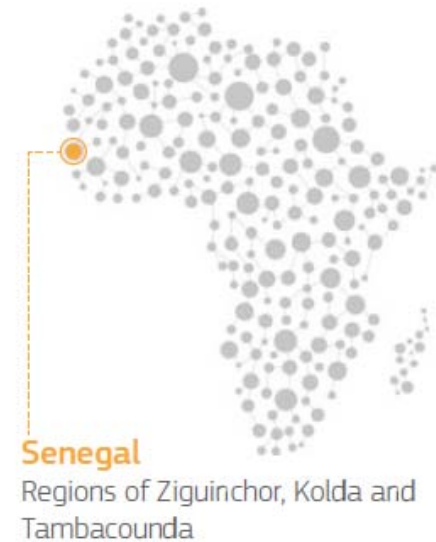
Village electrification in Senegal 2008: Best practice mini-grid in the village Ndelle



Village electrification in Senegal 2008: Best practice mini-grid in the village Ndelle



- No more than 15 percent of Senegalese rural households are connected to the grid.
- Ndelle, a 900 inhabitants village with 170 households identified in Kaolack Province Senegal is fully provided with solar power since 2008.
- A solar grid fed by three PV plants of 8,4 kWp joint capacity acts as model for the electrification of poor rural areas.
- Power storage is done with high-quality industrial lead acid batteries.
- The single phased 220 Volt AC-grid in Ndelle is extendable at will with any kind of power generator when demand reaches the capacity limit and it can be switched to three-phase operation by means of 3 parallel Battery inverters.
- Grid-connected small private consumers pay about 0,17 Euro/kWh and small commercial consumers pay about 0,24 Euro/kWh. People in Ndelle pay approx. 0,30 Euro/kWh.



Impressions from Ndelle



Impressions from Ndelle



Construction of support structures



Positioning and assembling of modules



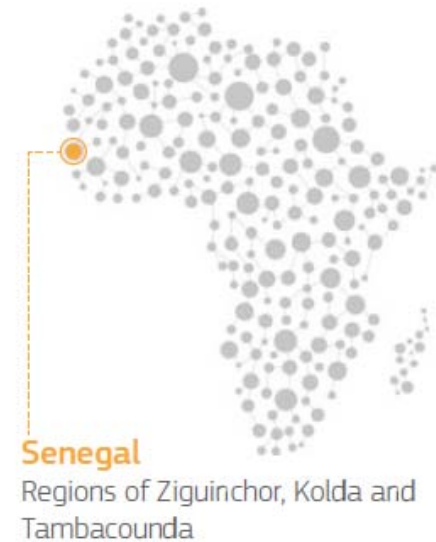
First module row finished



Cabling of modules

The mini-grid business model

- Project was initiated in cooperation with the German Energy Agency (dena) and co-funded by the German Ministry of Economics (BMWi)
- The consortium operating the village grid holds a mini-concession from the Senegalese Rural Electrification agency ASER.
- The power tariffs are set by the regulatory body CRSE
- The settlement is done according to the number of connected light bulbs or according to the consumed kWh
- **Local business involvement**
The photovoltaic system supplies power to a small supermarket and a welder, who have grown their businesses. It also supplies community services such as an electric mill for wheat, public street lighting, health center and primary school. Many private subscribers use the night extra times to extend their working hours.



Mini-grid extension in 2013 , after 5 years of successful operation



■ **Scaling Up**

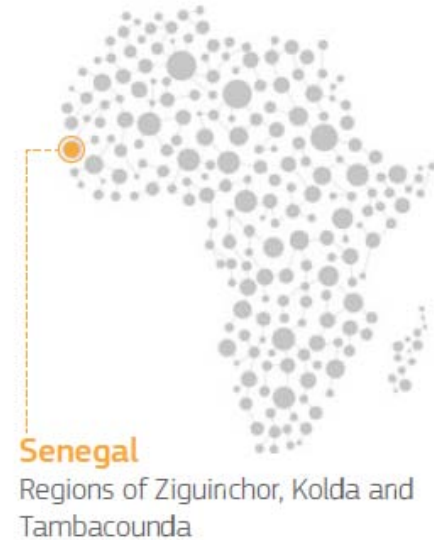
Since 2008, Ndelle's population has grown to more than 1.200 inhabitants and the villagers started to ask for more power. In 2012, the GIZ decided to scale-up the PV system by 50% to 14kWp capacity.

■ **Technology leap**

Thanks to the AC BUS grid technology offered by the German based technology company SMA, another grid tied inverter and a SUNNY ISLAND inverter charger were added to the existing system.

■ **Self-sustaining economics**

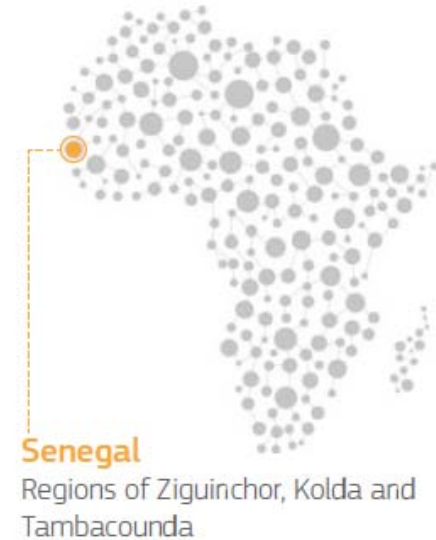
A commercial electrification project requires inhabitants being able to generate enough income from newly available power to pay for a tariff that enables the PV system to be maintained and possibly even expanded.



Since 2008, based on the good experience with Ndelle village, SOLAR23 and its local partner ENERGIE-R have electrified more than 100 villages in Senegal.



- The three target regions, Ziguinchor, Kolda and Tambacounda have the lowest income and the lowest electrification rate in Senegal. They will not be connected to the grid within the next 20 years.
- 40 villages each get a 20 kWp PV systems connected to a 2-3 km mini-grid and high quality batteries.
- The direct beneficiaries of the DPER project:
 - 3,000 un-electrified households
 - 150 micro entrepreneurs
 - 100 community services
 - More than 80 technicians trained
- Within 2020, the goal is to scale up to more than 10.000 mini-grids in the Sub-Saharan region



- Reliable power if properly designed: Modular and redundant design increases reliability
- Clean and silent with no pollution to the environment
- Easy to add solar power generation capacity increments
- Various auxiliary power sources possible (wind, diesel, hydro, grid)
- Centralized and therefore easier maintenance
- Provides higher power level for all consumers
- Standards AC household appliances can be used (3 x 230 / 400 VAC)
- Users do not need to make an upfront investment
- Users become subscribers with individual energy meters
- No waste nor loss of electricity: When single households do not consume power in the village it can be used by other households or stored in batteries
- Local socio-economic impact is important!



Thank you for your attention