# EXPERIENCE WITH THE ELECTRIFICATION OF THE HEALTH CENTRE OF DARSILAMI IN THE GAMBIA

**Michel Vandenbergh, Randolf Geipel, Markus Landau**
Institut für Solare Energieversorgungstechnik (ISET) e.V.
Königstor 59 D-34119 Kassel
tel +49-561-7294103
mvandenbergh@iset.uni-kassel.de

**Marthe Djuikom**
FERDEDSI (Forum des Energies Renouvelables pour le Développement Durable et la Solidarité Internationale)
P.O Box 300 Foumbot – West – Cameroun
djuikom2@yahoo.fr

**ABSTRACT:** The Gambian village of Darsilami is located at the southern border with Senegal. The population is estimated to be between 3000 and 4000 inhabitants, living in around 300 compounds. The PV-diesel hybrid system installed by ISET in December 2004 ensures a constant electricity supply for the health centre. The power station delivers enough power for the health centre appliances and a surplus of power. The next step of the project is to integrate income- generating uses, such as a battery charging station, in order to support the operating expenses and to contribute to better living standards for the villagers. This paper discusses the performance of the existing hybrid PV system and presents the village energy information system, developed for studying further electrification scenarios.

## 1 INTRODUCTION

The Gambian village of Darsilami is located at the southern border with Senegal (Casamance). The population is estimated to be between 3000 and 4000 inhabitants, living in around 300 compounds.

ISET has supervised the installation in 2004 of a PV-battery-Diesel hybrid system, which supplies continuous electricity to the Darsilami health center. The health center is equipped with a vaccine refrigerator and a small lab with medical devices for blood analysis, sterilization, etc. The power station was sponsored by the company REMIS who signed a new agreement with the village on 9$^{th}$ February 2008 when the health center was renamed “Health Center Remis” (HCR).

The hybrid power station is operated with a high solar fraction (97%), the back-up generator being used only in the raining season. A new project idea is to use the available surplus of PV energy to power a mini grid extension in the village. This new project supposes to integrate income- generating uses, such as a battery charging station, in order to support the operating expenses. Necessary socio-economical information about villagers was collected by the NGO FERDEDSI in February 2008, and was integrated in the Darsilami energy information system developed by ISET.

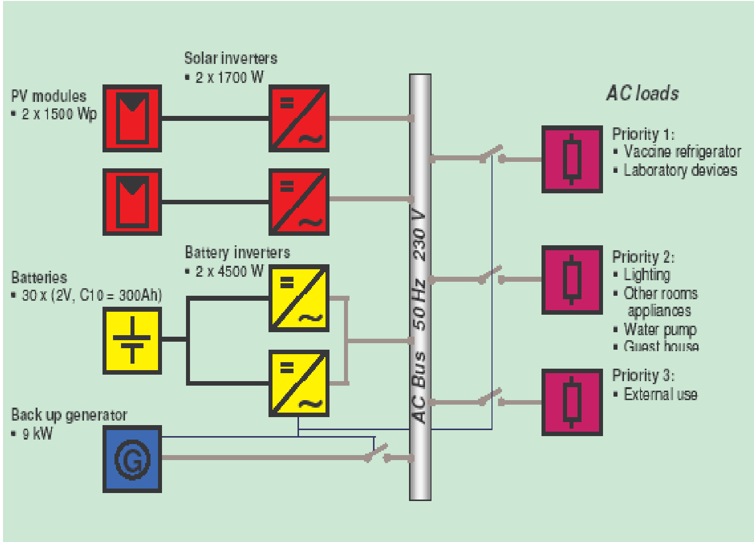



**Figure 1 : Power station in the Health Center of Darsilami, The Gambia**

## 2 TECHNICAL DESCRIPTION OF THE ENERGY CONTAINER

The power station is based on AC coupling (single phase, 230 V, 50 Hz) and fed by two strings of photovoltaic modules, each of 1500 Wp and connected to the AC bus with two 1700 W Sunny Boy solar inverters from SMA, oriented South with a 15° inclination angle. When solar radiation is insufficient to supply the loads, these are fed from maintenance free solar batteries (30x2 V, C10 = 300 Ah). A 9 kW back up diesel generator starts whenever the power from PV and batteries is insufficient to meet the load. At the heart of the system is the 4500 W Sunny Island(R) battery inverter. The battery inverter controls the automatic start of the Diesel genset for back up and boost charge. The minigrid has been designed to be expandable on both the demand side and the generation side. Slots for additional PV inverters and additional battery inverters exist in the container. A monitoring system records the power consumption, the power generation, the battery state of charge, the state of the grid and the solar radiation data.

## 3 MONITORING RESULTS OF THE ENERGY CONTAINER

The power station located at the Darsilami health Centre has been monitored by ISET since its installation in December 2004. Table 1 present the energy production and consumption measured on the AC bus for the different components of the power system after 3 years of operation. Most of the generation is almost equally shared between the 2 PV fields. Since its installation, the diesel generator has been used only during 123 hours for a total production of 298 kWh. This production represents only about 3% of the total energy mix. The generator is indeed used only during the raining season (August, September) if not enough solar resource is available.

| Device | Production kWh | Consumption kWh |
|---|---|---|
| Load outside container 1 | | 1476.7 |
| Load outside container 2 | | 1211.3 |
| Load outside container 3 | | 435.7 |
| Load inside container 1 | | 730.1 |
| Load inside container 2 | | 1901.9 |
| Storage (Battery+ inverter) | 3480.9 | 7344.5 |
| Solar field1 | 4641.2 | |
| Solar field2 | 4680.3 | |
| Diesel generator | 297.8 | |
| **Total (with storage)** | **13100.2** | **13100.2** |
| Total (without storage) | 9619.3 | 5755.7 |

**Table 1: Energy statistics since December 2004 until February 2008.**

Loads have been classified in 5 categories. The loads outside the container are located in the health centre with 3 levels of priority (1 being the highest). The highest priority loads include a fridge with the vaccines and other loads (eg. Sterilisator, PC), which are rarely used. The priority 2 loads include the night lights and several special loads which are not necessary for the operation of the health centre. The out patient visits take place exclusively in the morning and in the afternoon, the Health Centre is open only for emergency situations. However, special loads are connected in the afternoon. These include several loads from a group of Gambian armed forces who is camping near the village (charger for 6 talkie walkie, DVD player which is played while waiting for the talkie walkie batteries to be charged and mobile phones). Other loads whose owner is not clearly identified include a car battery charger and a big freezer. Finally, the priority 3 load is an out of order water pump, which was planned to be used for dumping excess PV power. Inside the container, normal loads, totalizing about 50 W, are the ventilator for cooling the batteries, the data-logger and a computer, which is started for a short period in order to backup the monitoring data. In addition, unidentified loads up to 300 W were connected in the container by the local technician. Probably, battery charging was organized in the container.

The structure of the energy consumption is illustrated in Figure 2. The biggest energy consumer (40%) is the battery storage system. These losses could be reduced by increasing the efficiency of the inverter and by reducing the daily cycling of the battery (eg. by a better matching of the power curve for deferrable loads to the availability of the solar resource). Loads really necessary for the operation of the health centre represent only a small part of the total energy consumption. Other loads (battery charging, freezer, DVD player) for private or military uses represent an increasing share of the energy consumption. Instead of providing free power, it is planed to collect money for the system maintenance by allowing the connection of the special loads only via a pre-payment meter.

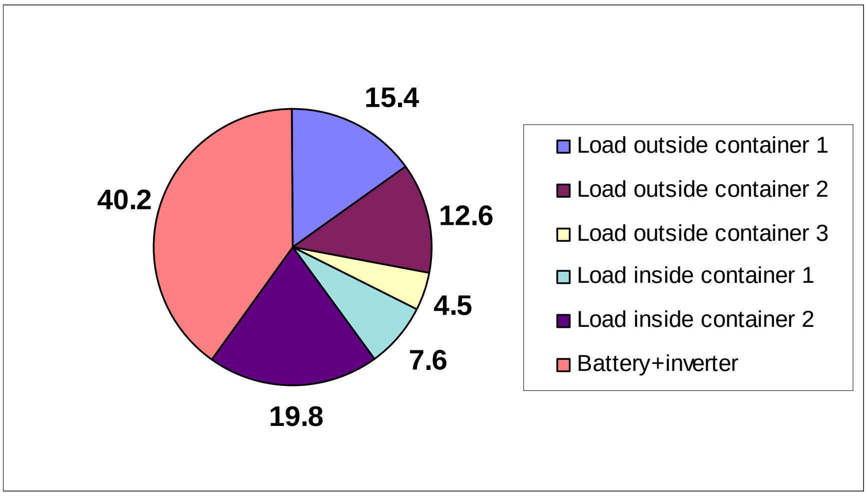


**Figure 2 : Energy consumption structure (in %)**

The daily cycles are illustrated by three days of measurements in February 2008 (from 04.02.2008 until 06.02.2008). In Figure 3, the total load is plotted with the real and reference power of PV field2 (representing 50% of total solar production). Due to the battery being full in the early afternoon (Figure 4), the PV power is de-rated by the PV inverters. This would be the best time for switching on the deferrable loads. However, the special loads, not necessary for the operation of the health centre, should be stopped in the evening. It can be seen that some efforts could be done for a better use of the solar resource by avoiding to connect deferrable (= non necessary) loads in the evening (=after 5pm).

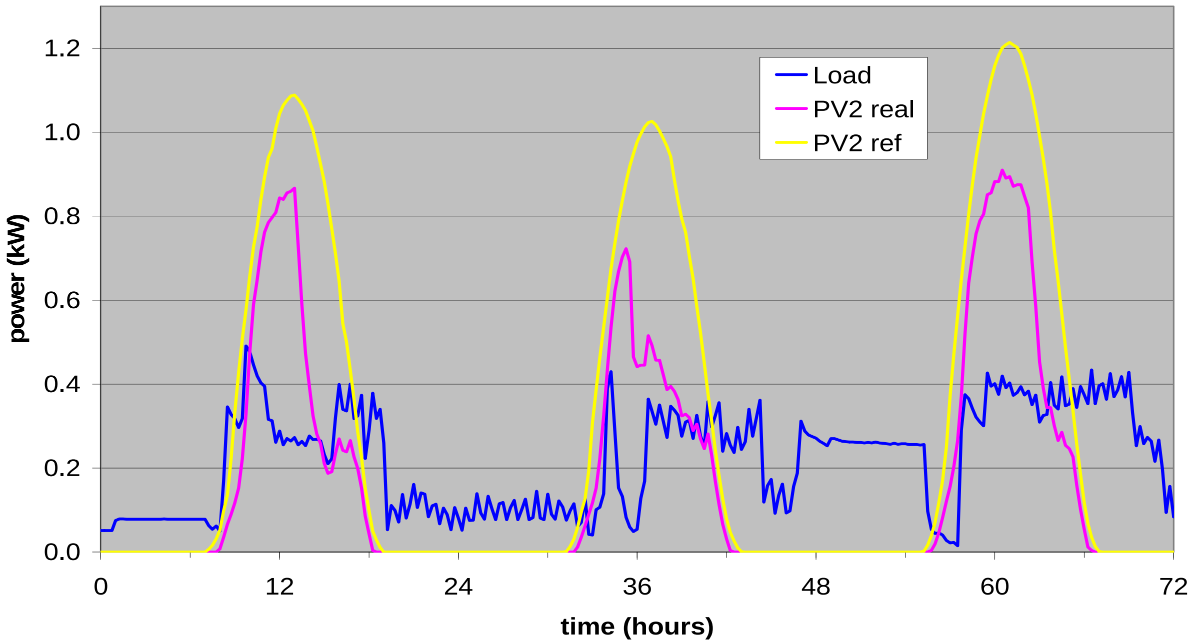


**Figure 3 : User load, real and reference power of PV field 2 (04-06.02.2008)**

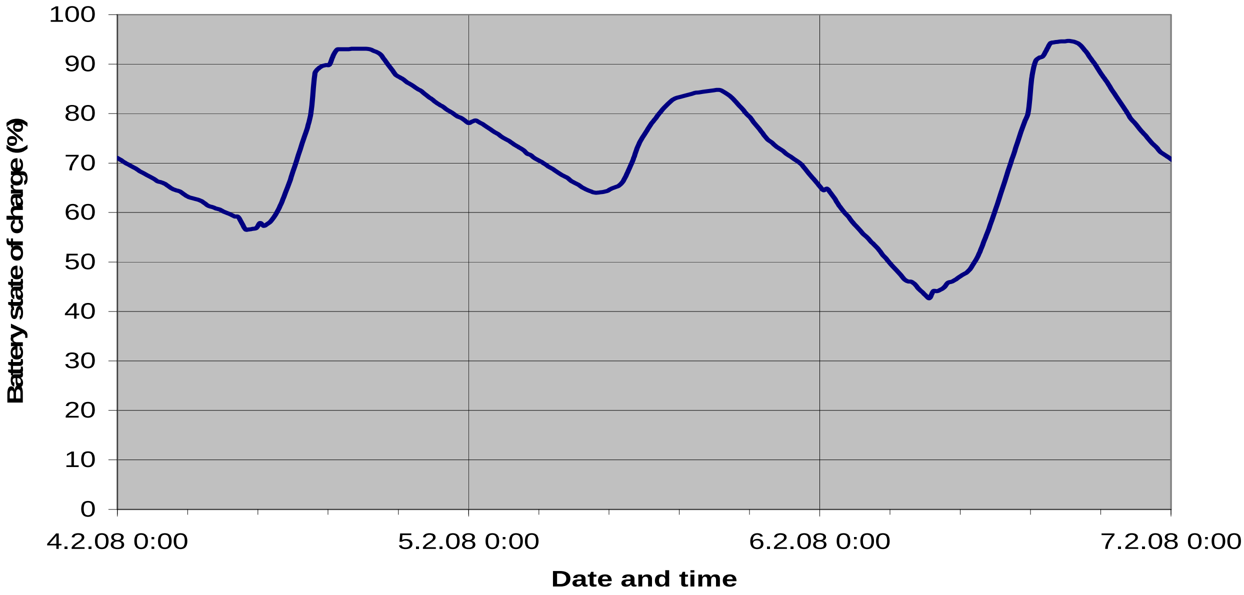


**Figure 4 : Typical daily cycling of the battery**

## 4 DARSILAMI ENERGY INFORMATION SYSTEM

In 2008, a socio-economical survey was organized in Darsilami in two phases:

1. Evaluation of the village situation. The aim was to have an overall information about the village and different stakeholders involved in one way or another in an action of development in the village. It included various meetings with different stakeholders and a popular meeting with people in the village.
2. Survey at the household level. This included using questionnaires for gathering general information on households, evaluating households' needs, ability and willingness to pay for energy services, and getting opinion on new electricity services.

The investigation concerned 76 households, which represent a bit less than 1/3 of the total village (the total number of households is estimated to 255). The household size is 5 to 40 people. 54% of the population is up to 30 years old and 72% up to 50. This indicates that the population is relatively young. In order of importance, people spend 55% of their income for food, 18% for energy and 7% for phone. For lighting purposes, candle, kerosene, LED and torch are used as well as electricity from car batteries, power generator and solar panels. Various electrical appliances are used in the village. The 76 surveyed households declared 165 mobile phones, 150 radios and tape players, 35 TV, 10 fridges and freezer, 7 computers, 11 VCD, 13 fans and 15 various appliances (among which 4 sewing machines and a laser printer). The information of the questionnaires was integrated in the Darsilami energy information system, together with GPS points, photos and a 1m resolution satellite image. This energy information system provides a good tool for studying electrification scenarios (Figure 5).

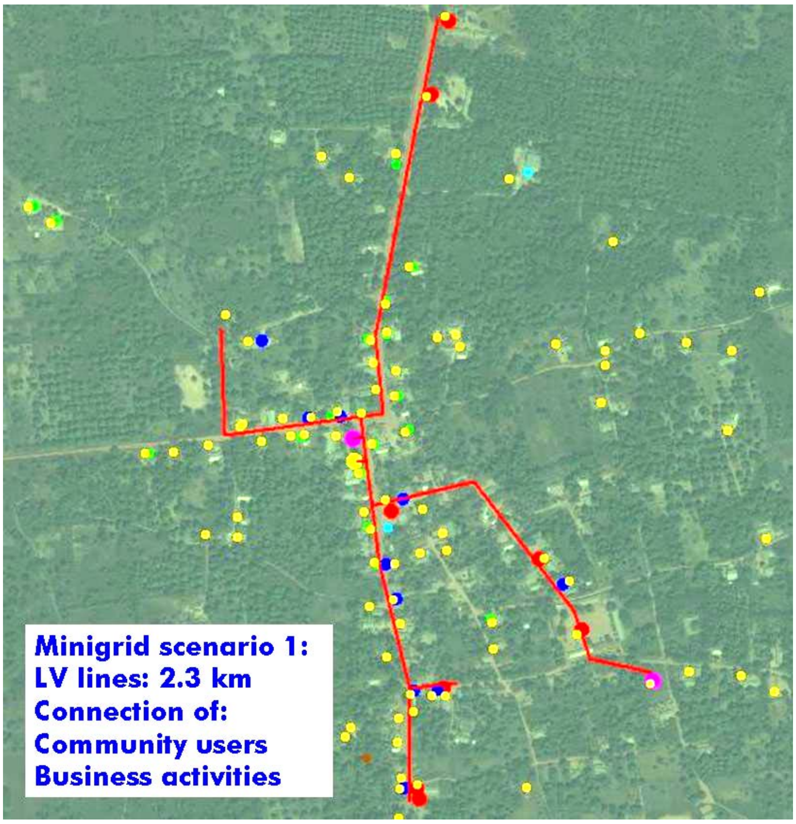


**Figure 5 : Map showing a scenario for a mini-grid extension interconnecting the community buildings and business activities in Darsilami**

## 5 CONCLUSIONS

Since December 2004, a PV-diesel hybrid system successfully supplies with electricity a health centre in the village of Darsilami. From the very start of the project, an interdisciplinary approach was adopted, which tries to conciliate the technical and the social aspects. The ultimate goal is to supply both the health centre and small income-generating businesses which require electricity and which are practically and commercially beneficial for the villagers. The PV/diesel system has the potential to provide more power than the amount strictly needed by the health centre. The results of a detailed socio-economical survey, realized in 2008, are integrated in an energy information system which will be used for future electrification projects in the village.

## 6 REFERENCES

[1] Marthe Djuikom: Electricity supply in Darsilami - Gambia: Socio-economic studies for a minigrid installation project - FERDEDSI unpublished report, 04.2008

[2] R. Geipel, M. Landau, J. Schmid, P. Strauß, M. Vandenbergh, P. Schweizer-Ries, P. Isfort, “Experience with the Electrification of a Gambian Village- 21st European Photovoltaic Solar Energy Conference, Dresden, September 04-08, 2006