# Energy baseline development, tariff study and tool, O&M plan and manual and capacity building for the 500 kWp solar PV mini-grid in Bissorã, Guinea Bissau

## TASK 2 – Energy baseline

Final report

Prepared for:

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| Project: | Energy baseline development, tariff study and tool, O&M plan and manual and capacity building for the 500 kWp solar PV mini-grid in Bissorã, Guinea Bissau |
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**ENERGY BASELINE REPORT**

# DELIVERABLE #2: Energy Baseline Report

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| Inception report | PDF | Final | 19/9/2017 |
| Annex 1 – Chief questionnaire | Word | Draft | 19/9/2017 |
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| Annex 3 – IPP questionnaire | Word | Draft | 19/9/2017 |
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**PRESENTATION**

This report is the Deliverable #2 from the technical assistance offered to UNIDO for the development of the 500 kWp solar PV mini-grid in Bissorã, Guinea Bissau

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# Table of Acronyms

| Abbreviations | Explanation |
|---|---|
| **ABREC-SABER** | African Biofuel and Renewable Energy Company |
| **ADPP** | Ajuda de Desenvolvimento de Povo para Povo |
| **ARPU** | Average revenues per user |
| **ACDB** | Associação Comunitária de Desenvolvimento de Bambadinca |
| **ATP** | Ability to pay |
| **ECREEE** | ECOWAS Centre for Renewable Energy and Energy Efficiency |
| **EU** | European Union |
| **GEF** | Global Environmental Facility |
| **GHG** | Greenhouse Gas |
| **IPP** | Independent power producer |
| **KPI** | Key performance indicator |
| **kWp** | Kilowatt peak (refers to installed photovoltaic capacity in STC) |
| **MWh** | Megawatt-Hour |
| **O&M** | Operation and maintenance |
| **PV** | Photovoltaic |
| **PSH** | Peak sun hours |
| **STC** | Standard test conditions |
| **TTA** | Trama TecnoAmbiental |
| **UF** | Utilisation factor |
| **UNIDO** | United Nations Industrial Development Organization |
| **WAEMU/UEMOA** | West African Economic and Monetary Union |
| **WTP** | Willingness to pay |

# 1. Introduction

Following the Call for Proposals issued by the United Nations Industrial Development Organization (UNIDO) in July 2017, Trama TecnoAmbiental (TTA) was awarded a contract for the "Energy baseline development, tariff study and tool, O&M plan and manual and capacity building for the 500 kWp solar PV mini-grid in Bissorã, Guinea Bissau". The main objective of this project is to develop the soft issues around the 500 kWp solar PV mini-grid to ensure a sustainable and durable project.

This project is part of the Global Environmental Facility (GEF). The GEF Project (ID 5331) entitled "Promoting investments in small to medium scale renewable energy technologies in the electricity sector of Guinea-Bissau" is executed by UNIDO in close partnership with the Ministry of Energy and Industry of Guinea Bissau, the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) and the Small Island Sustainable Energy and Climate Resilience Organization (SIDS DOCK).

In this context, UNIDO, the West African Economic and Monetary Union (WAEMU/UEMOA) and the African Biofuel and Renewable Energy Company (ABREC-SABER) are partnering for the construction of a solar PV hybrid mini-grid for the city of Bissorã with a total installed solar PV capacity of 500 kWp. The company Prosolia Africa has been contracted to undertake the required civil works and turn-key installation of the power station.

The city of Bissorã is a peri-urban hub and an important administrative centre of the Oio region. According to a preliminary survey, Bissorã presents economic dynamism thanks to its administrative role. It has around 14.000 inhabitants (1.300 households, with an average of 11 inhabitants per household), 275 businesses including shops, hotels, 1 hospital, 10 schools, 1 police station, 4 administrative offices, wood saws, a youth centre as well as 4 mosques and churches. Currently some have private gensets or are connected to electricity services through informal independent power producers (IPP).

Through a desk study of previous work in Bissorã, reference projects in the area (i.e. Bambadinca mini-grid) and a field visit, TTA has elaborated an energy baseline for Bissorã town. The present study further examines three scenarios. A *base scenario* considering 470 connections (equal to the number of meters procured for the initial phase of the project as of Q1 2018) and the current demand of the potential end-users found during the site visit. A second scenario (*intermediate scenario*) estimates the maximum number of connections that the 500 kWp mini-grid can cover only with solar power and a third one (*future scenario*) calculates the total potential demand of Bissorã and the possible necessities of expansions of the generation plant and distribution line.

# 2. Methodology

The methodology followed by TTA for the definition of the energy baseline combines real data collected during two site visits (2-6/10/2017 and 7-8/2/2018), consumption data from Bambadinca's mini-grid (covering the period between December 2016 and June 2017), as well as various assumptions based on TTA's long experience in rural electrification. The flowchart below describes the process that has been followed in order to build the energy baseline of the Bissõra community.

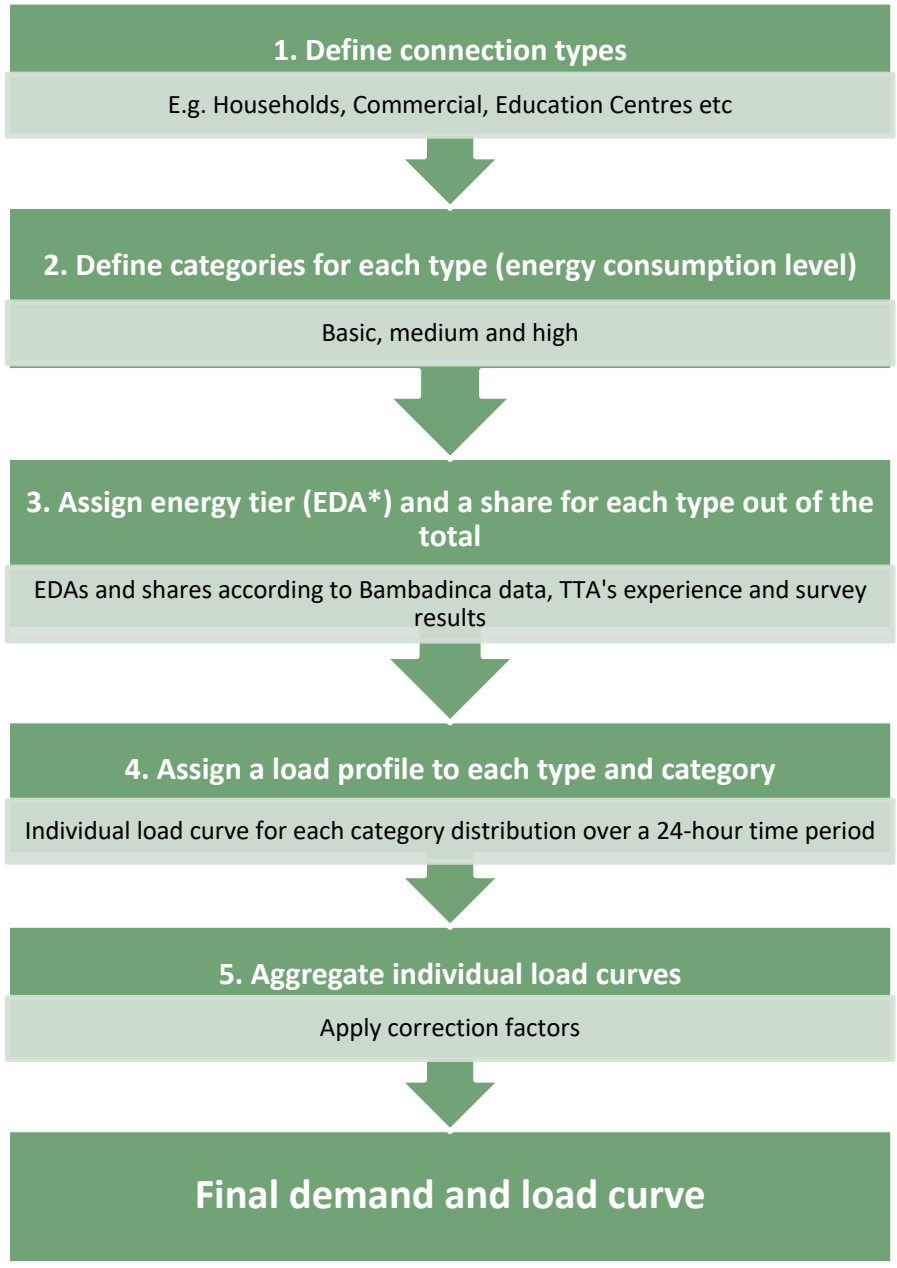


Figure 1: Flowchart for energy baseline estimation

*The energy daily allowances (EDA) are TTA's standardised energy tiers assigned to the connections and are multiples of the basic EDA of 550 Wh/day

# 3. Data gathering

## 3.1. Population and growth

Table 1 shows the population of Bissorã according to the 2009 census, distributed by neighbourhoods ("bairros").

Table 1: Bissorã population per neighbourhood according to 2009 census

| # | Neighbourhood | Population (2009 census) |
|---|---|---|
| 1 | Joaquim N'com 1 | 390 |
| 2 | Joaquim N'com/N'tchantcha | 639 |
| 3 | Joaquim N'com/Madina | 874 |
| 4 | Joaquim N'com/Argentina (incl. Veterinaria) | 944 |
| 5 | Braga 1 | 1239 |
| 6 | Braga 2 | 937 |
| 7 | Sintcha | 562 |
| 8 | Praça | 475 |
| 9 | Santa Luzia | 982 |
| 10 | Santa Luzia (2) | 718 |
| 11 | Gã- Cemiteiro | 239 |
| 12 | Gã-Djugude | 279 |
| 13 | Gã-Banana | 325 |
| 14 | Missira | 341 |
| 15 | Outra Banda | 491 |
| 16 | Touba | 85 |
| | **TOTAL** | **9.520** |

According to collected information, between 2009 and 2017, population in Sintcha has increased by 130% and in Santa Luzia 73%, or around 100% as an average in 8 years. We can assume a total increase in Bissora's population of 50% between 2009 and 2017 as a conservative estimation or 5.2% per year, totalling to **14.280** inhabitants.

Assuming 11 people per household (experience from Bambadinca, whereas otherwise is 6 for Guinea Bissau), the final number of households in Bissorã considered for the study is **1.298**.

Note: The previous highlighted data of 1.298 households was confirmed by the participants during the Energy Baseline Workshop that took place in Bissau on the 8th of February 2018.

## 3.2. Energy uses and future needs

Currently, the main economic activities in Bissorã are agriculture, commerce and services, since Bissorã is a main administrative hub for the northern region of the country. Typical energy uses at the moment are lighting and product conservation.

There is no single typical light bulb used at the moment; during the site visits different ones were observed ranging from efficient ones to up to 60 W. However efficient LED of 8-15-20 W can be purchased locally starting from 5000 CFA.

There are two types of fridges identified: the ones consuming 160 W and 1.1 kWh over 24 hours (46 W on average per hour) and the ones consuming 200 W and 2 kWh over 24 hours (80 W on average per hour). They cost 490.000 XOFs (746 EUR) in Bissau.

**Institutional**:

The administration buildings include ministry buildings, the house of justice, police, etc. They do not have any connection to thermal units at the moment and their internal wiring is old and would need revision in order to connect to the mini-grid (estimated cost of upgrade between 40 and 120 €). Nonetheless, from an interview conducted to the house of justice, they are eager to receive lights, computers, AC units and photocopy machines.

Other institutional users include religion places, schools and a hospital, as well as a water pump, currently working on diesel generator and foreseen to connect to the mini-grid. Additionally, there are water wells but are not planned to switch to electric ones and connect.

Street lighting has been already installed at some parts along the distribution line. There are also streetlights based on individual solar panels, as seen in the following image.

Figure 2: Solar street light (left) and grid-connected one (right) in the administrative district of Bissorã

The total number of potential institutional connections is seen below:

Table 2: Institutions potentially to connect to the mini-grid

| Institutions | Number |
|---|---|
| **Churches** | 2 |
| **Mosques** | 3 |
| **Education centres (daily)** | 9 |
| **Boarding schools** | 1 |

| Institutions | Number |
|---|---|
| **Health facilities** | 1 |
| **Administrative (Police, DRA, court)** | 3 |
| **Water pump** | 1 |
| **Street light** | 1 |
| **TOTAL** | **21** |

**Commercial:**

There are around 272 commercial users, most of which already have a connection to a private or shared genset (informal mini-grid), as well as a small solar panel for lighting. Besides small shops and restaurants, anchor loads identified are a wood processing factory, a telecommunication tower, a water pump and the market. Other relatively large consumers would be the pharmacies, the veterinary and the hotel.

The fee for 4 hours of service through the informal mini-grids is 15.000 FCFA/month supplying lighting and plugs or 25.000 FCFA/month for additionally having a fridge ("arca"). It can be assumed that with a continuous electricity service from the mini-grid, two thirds (2/3) of the commercial users shall have fridges. A typical commercial street is shown below.

Figure 3: Image of a typical commercial street in Bissorã

The largest potential consumer identified in Bissora town is the wood processing factory ("serralheria"), having shown interest in connecting to the mini-grid. It consists of a compound with various heavy equipment currently supplied by a 120 kW genset, consuming 60 L of diesel per day during 8 working hours, all year round.

Figure 4: General aspect of wood processing factory (left) and electrical cabinet (right)

There are two telecommunication stations in the entrance of the village, one from MTN running on a private genset and one from Orange with a 12 kWp PV with storage. For the purposes of this energy baseline, it is assumed that the MTN tower will be connected to the mini-grid service.

Furthermore, the MTN agency has a genset for its own use but also serves as an informal Independent Power Producer (IPP). They consume 10 L/day (33 kWh/day), while at the time of visit they were charging 90 mobile batteries through LCD universal chargers that consume around 2 W, as shown below. Daily they can charge 270 batteries of 4 hours each, leading to 2.16 kWh/day of consumption.

Figure 5: LCD universal charger in Bissorã

Future commercial and productive uses reported are: a cinema, sewing machines, rice mills for the women association and refrigeration units.

The association of traders in Bissorã has expressed the desire to implement a central refrigeration point in the main market in order to offer refrigeration space for the traders (instead of each of them owing individual refrigerators). Thus, the market can be considered as an independent connection for 5 chest freezers. Moreover, at the moment there is no ice production unit in Bissorã and ice is imported from Bissau on daily basis. An estimation is that after the connection of the market to the mini-grid, they will acquire an ice-making machine in order to produce it locally.

Two user groups were identified with a potential of electricity usage for productive uses: the women association operating rice mills and the carpenters currently working with manual tools such as saws. While they didn't express immediate interest in switching to electric tools, the savings and income generation potential of such conversion could be assessed in more detail during next visits.

The following table list the potential commercial connections in Bissorã town:

Table 3: Businesses potentially to connect to the mini-grid

| Businesses | Number |
|---|---|
| **Shops** | 237 |
| **Restaurants and bars** | 18 |
| **Pharmacies** | 3 |
| **Veterinary** | 1 |
| **Guesthouses** | 1 |
| **Wood treatment workshop** | 1 |
| **Carpentry** | 3 |
| **Telecommunications towers** | 1 |
| **Grain mills** | 4 |
| **Cinema** | 1 |
| **Sewing machines** | 1 |
| **Market** | 1 |
| **TOTAL** | **272** |

## 3.3. Current situation of distribution grid

According to the available latest data of the project implementation, the distribution grid that has been in place is capable to connect at least 470 users, equal to the number of meters currently been purchased for the project. Nonetheless, the current length of the distribution grid does not pass through the whole town. Five out or 16 neighbourhoods are out of reach (namely Joaquim N'com/Argentina, Sintcham, Gã-Banana, Missira and Touba), which represent the 24% of the total population of Bissorã. This means that a universal connectivity could only be achieved with an extension of the distribution grid, something which costs around 20,000 € per kilometre.

# 4. Demand estimation

## 4.1. General assumptions

Based on the aforementioned information and TTA's methodology, a complete load profile has been assessed for Bissorã. The steps followed and main assumptions include:

- For the 59 potential end-users interviewed, the daily energy demand has been estimated in order to create the energy baseline of Bissorã (design demand). Then this is adjusted based on Bambadinca's data and TTA's experience.
- Lighting: For the total number of light bulbs observed during the visit of the 59 potential end-users, it is assumed a simultaneity factor of 50%
- Water pump: In order to calculate the electricity demand, it has been considered that the water necessities are 30 L/person/day (information collected from the end-user questionnaires). Assuming an average borehole depth of 25 m, the energy needed for pumping water is calculated based on the village's population and distributed across five hours within a day, from 10:00 to 15:00.
- Street lighting: It has been assumed one light of 40 W for every 16 households functioning from 18:00 to 6:00
- Utilisation factor of 70% has been considered
- Grain mills: There is no specific information of the 4-grain mills existing so assumptions have been made. It is considered that after the mini-grid operation, the grain mills will be electric of 1.1 kW. Half will produce 30 kg/day during 2 hours of functioning and half will produce 60 kg/day in 4 hours of graining.

- For all consumer types, a load profile is given according to TTA's standardisation methodology of tariffs per type of connection and adapted for the specific conditions of Bissorã, with additional inputs from Bambadinca.
- For the market's connection, it is assumed that there are 5 chest freezers consuming 2 kWh/day and an ice making machine of 1.1 kW working 5 hours per day.
- The interviewees were asked about the desired future loads. There was a lot of variation in the answer, ranging from 0% to a 3000% of difference between their current demand and their desired remand. In order to get as realistic results as possible for the energy baseline, it was assumed that the EDA of each customer for the design is up to double than their current declared demand

## 4.2. Individual load profiles

The individual load profiles used for each connection type are shown in Figure 6.

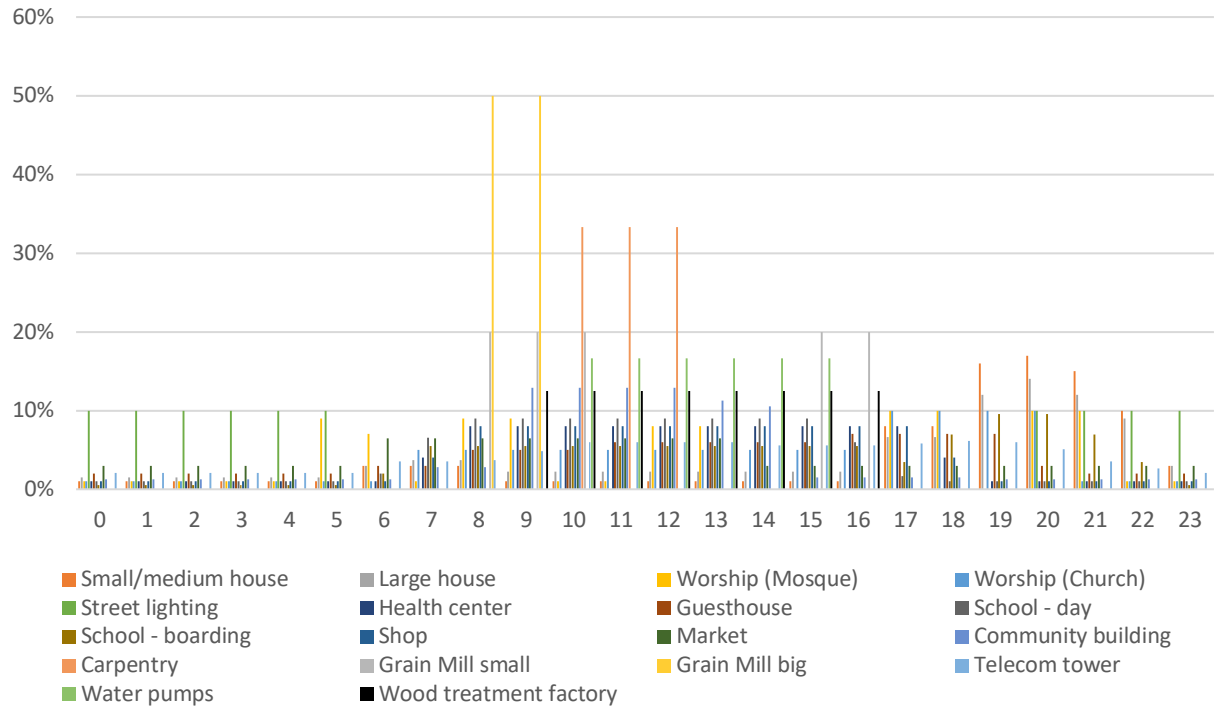


**Figure 6: Individual load profiles for energy baseline**

# 5. Energy baseline results

The energy baseline of Bissorã has been created taking into account three different scenarios, as described in the paragraphs below:

## 5.1. Base scenario

In this scenario the number of connections is equal to the number of meters already purchased for the project (470). This would be enough to connect 20% of the existing households (HH), 65% of the existing commercial users (CO) and all other aforementioned connections. The energy tiers (EDAs) assigned to each connection type are estimated from the current demand according to the end-user inquiries and TTAs experience.

The shares shown in Table 4 have been derived from surveys and from TTA's visit to Bissorã, where demand patterns for each customer group were estimated. In addition, the estimations have been validated by analysing real demand data from Bambadinca, where it was found that the average household consumes 0.87 kWh/day while an average shop consumes 1.37 kWh/day. It is expected that these customer groups will display similar average consumption figures in Bissorã.

For individual customers such as the guesthouse, wood treatment workshop and worship places, the direct information from the interviews has been used.

Table 4: Energy demand assessment under Base Scenario

| Type | Category | EDA (Wh/day) | Share | Number | Total EDA (Wh/day) |
|---|---|---|---|---|---|
| **Households** | basic | 550 | 75% | 203 | 111.650 |
| | medium | 1.650 | 20% | 54 | 89.100 |
| | high | 3.850 | 5% | 13 | 50.050 |
| **Commercial*** | basic | 550 | 40% | 69 | 37.950 |
| | medium | 1.650 | 55% | 94 | 155.100 |
| | high | 3.850 | 5% | 8 | 30.800 |
| **Community buildings** | basic | 1.100 | 67% | 2 | 2.200 |
| | medium | 1.100 | 0% | 0 | 0 |
| | high | 1.650 | 33% | 1 | 1.650 |
| **Education centres** | basic | 2.200 | 33% | 4 | 8.800 |
| | medium | 4.400 | 33% | 3 | 13.200 |
| | high | 7.150 | 33% | 3 | 21.450 |
| **Churches** | basic | 2.200 | 50% | 1 | 2.200 |
| | high | 7.700 | 50% | 1 | 7.700 |
| **Mosques** | basic | 1.100 | 67% | 2 | 2.200 |
| | medium | 1.100 | 0% | 0 | 0 |
| | high | 2.200 | 33% | 1 | 2.200 |
| **Wood processing factory** | basic | 150.000 | 100% | 1 | 150.000 |
| **Health facilities** | basic | 16.500 | 100% | 1 | 16.500 |
| **Guesthouse** | basic | 88.000 | 100% | 1 | 88.000 |
| **Water Pump** | basic | 29.155 | 100% | 1 | 29.155 |
| **Telecom Towers** | basic | 53.350 | 100% | 1 | 53.350 |
| **Grain Mills** | basic | 2.200 | 50% | 2 | 4.400 |
| | high | 4.400 | 50% | 2 | 8.800 |

| Type | Category | EDA (Wh/day) | Share | Number | Total EDA (Wh/day) |
|---|---|---|---|---|---|
| **Market** | basic | 15.500 | 100% | 1 | 15.500 |
| **Street Lights** | basic | 38.945 | 100% | 1 | 38.945 |
| **TOTAL energy** | | | | | **941 kWh/day** |

*Commercial: include pharmacies, shops, MTN agencies offering phone charging services, carpenters, restaurant and bars, vets and sewing machines

Considering a 60% plant performance ratio and 6 peak sun-hours, the total daily energy demand of 941 kWh/day (343 MWh/year) would require a **261kWp** PV plant installed capacity.

With an emission factor of electricity production with gensets equal to 0.8 $kgCO_2eq./kWh$[1], the savings in greenhouse gas (GHG) emissions would be 274.743 $kgCO_2eq./year$, in case all demand would be covered by diesel generators.

The load curve for the base scenario is shown in Figure 7 and the distribution of consumer type in Figure 8, demonstrating that in the base scenario, the majority of Bissorã consumption is due to commercial loads.

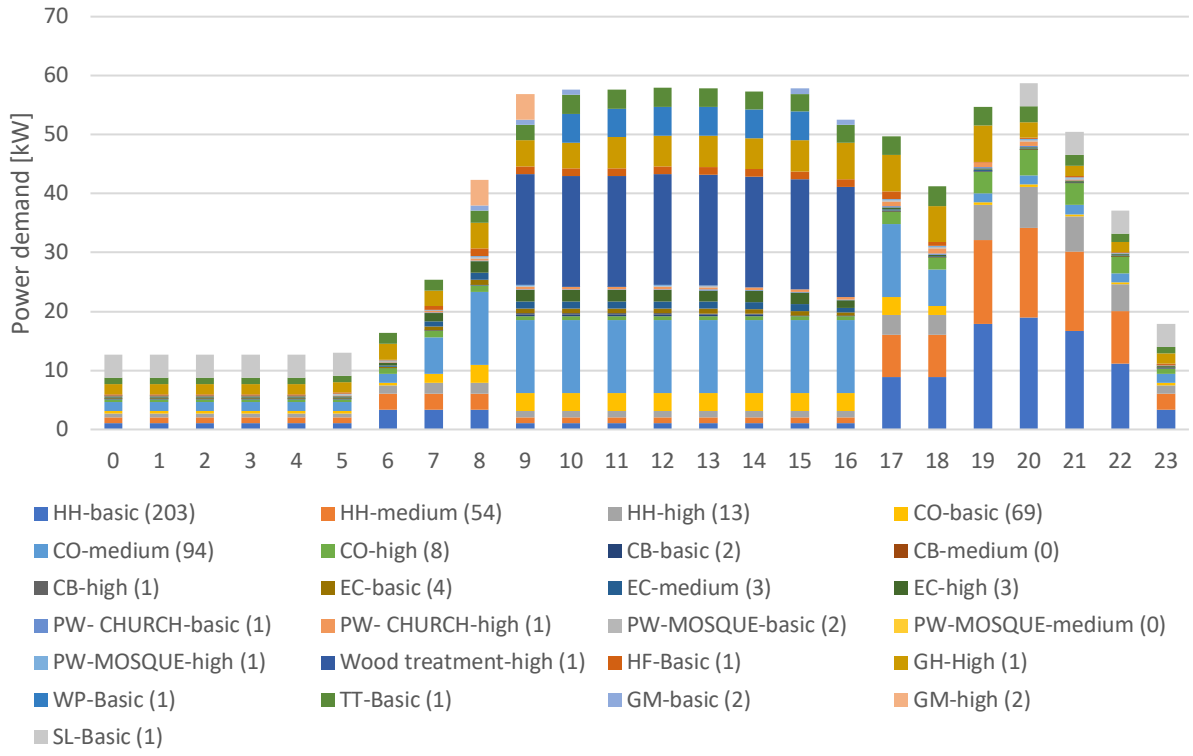


Figure 7: Bissorã load curve under Base Scenario

[1] EPA, 2014. Emission Factors for Greenhouse Gas Inventories.
Found at: https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

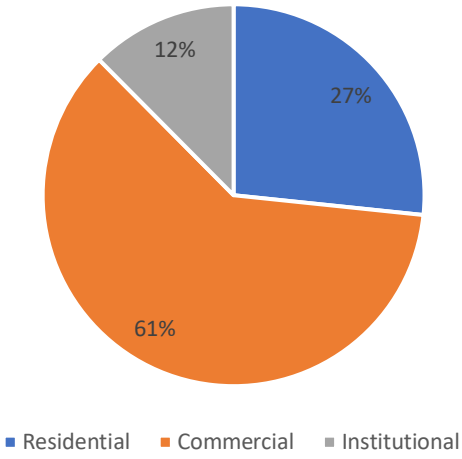


Figure 8: Pie chart of consumer types under Base Scenario

## 5.2. Intermediate scenario

This scenario estimates the maximum number of connections that the 500 kWp mini-grid can cover only with solar power, based on the same distribution of connections as the base scenario. This could be achieved with 82% connectivity of the households and 100% connectivity of the commercial connections, as of their current number or a total of 1357 connections. The results are shown in Table 5.

Table 5: Energy demand assessment under Intermediate Scenario

| Type | Category | EDA (Wh/day) | Share | Number | Total EDA (Wh/day) |
|---|---|---|---|---|---|
| **Households** | basic | 550 | 75% | 794 | 436.700 |
| | medium | 1.650 | 20% | 211 | 348.150 |
| | high | 3.850 | 5% | 52 | 200.200 |
| **Commercial*** | basic | 550 | 40% | 106 | 58.300 |
| | medium | 1.650 | 55% | 145 | 239.250 |
| | high | 3.850 | 5% | 13 | 50.050 |
| **Community buildings** | basic | 1.100 | 67% | 2 | 2.200 |
| | medium | 1.100 | 0% | 0 | 0 |
| | high | 1.650 | 33% | 1 | 1.650 |
| **Education centres** | basic | 2.200 | 33% | 4 | 8.800 |
| | medium | 4.400 | 33% | 3 | 13.200 |
| | high | 7.150 | 33% | 3 | 21.450 |
| **Churches** | basic | 2.200 | 50% | 1 | 2.200 |
| | high | 7.700 | 50% | 1 | 7.700 |
| **Mosques** | basic | 1.100 | 67% | 2 | 2.200 |
| | medium | 1.100 | 0% | 0 | 0 |
| | high | 2.200 | 33% | 1 | 2.200 |
| **Wood processing factory** | basic | 150.000 | 100% | 1 | 150.000 |
| **Health facilities** | basic | 16.500 | 100% | 1 | 16.500 |

| Type | Category | EDA (Wh/day) | Share | Number | Total EDA (Wh/day) |
|---|---|---|---|---|---|
| **Guesthouse** | basic | 88.000 | 100% | 1 | 88.000 |
| **Water Pump** | basic | 29.155 | 100% | 1 | 29.155 |
| **Telecom Towers** | basic | 53.350 | 100% | 1 | 53.350 |
| **Grain Mills** | basic | 2.200 | 50% | 2 | 4.400 |
| | high | 4.400 | 50% | 2 | 8.800 |
| **Market** | basic | 15.500 | 100% | 1 | 15.500 |
| **Street Lights** | basic | 38.945 | 100% | 1 | 38.945 |
| **TOTAL energy** | | | | | **1.799 kWh/day** |

*Commercial: include pharmacies, shops, MTN agencies offering phone charging services, restaurant and bars, vets and sewing machines

Considering a 60% plant performance ratio and 6 peak sun-hours, the total daily energy demand of 1.799 kWh/day (657 MWh/year) would require a **500kWp** PV plant installed capacity.

With an emission factor of electricity production with gensets equal to 0.8 $kgCO_2eq./kWh$[2], the savings in greenhouse gas (GHG) emissions would be 525.279 $kgCO_2eq./year$, in case all demand would be covered by diesel generators.

The load curve for the intermediate scenario is shown in Figure 9 and the distribution of consumer type in Figure 10, demonstrating that under this scenario, the majority of Bissorã consumption is due to residential loads.

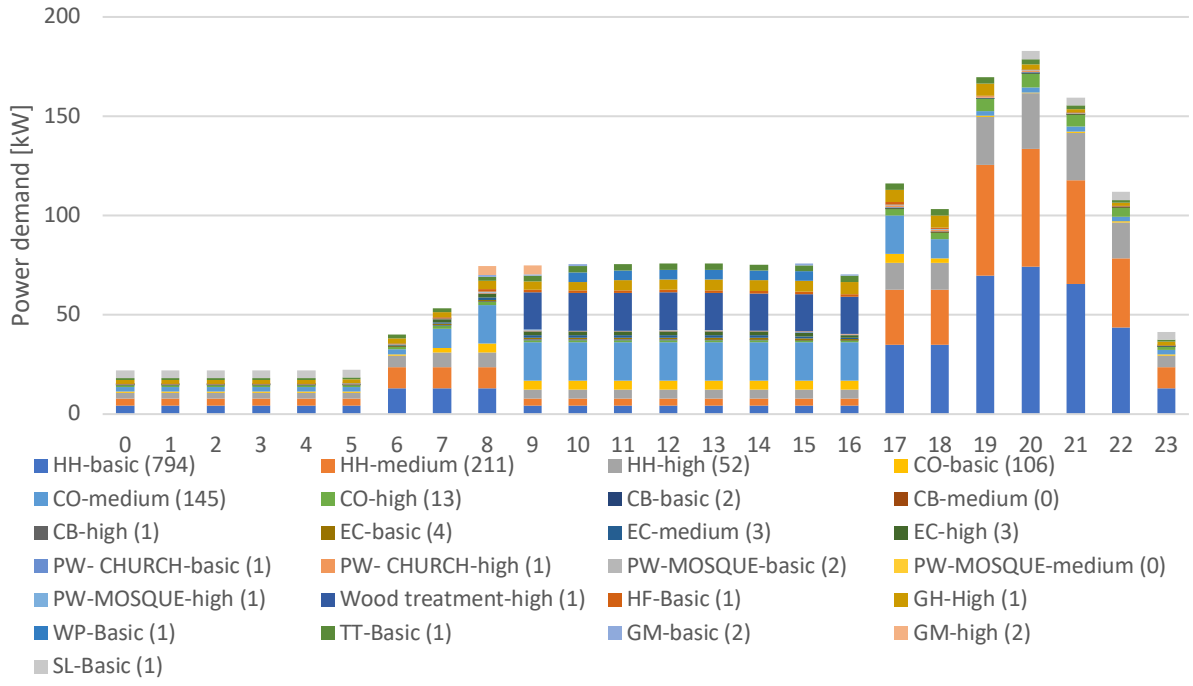


Figure 9: Bissorã load curve under Intermediate Scenario

[2] EPA, 2014. Emission Factors for Greenhouse Gas Inventories.
Found at: https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

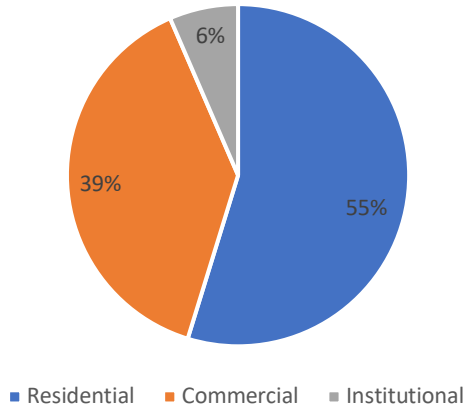


Figure 10: Pie chart of consumer types under Intermediate Scenario

## 5.3. Future scenario

The hypothesis assumed in this scenario are:

- The total number of households and commercial users increases by 10% as to the current situation.
- The connectivity rate of households is 90% and of commercial connections is 100%
- The average daily demand of the households and commercial connections increases by 20% regarding the demand in the base and intermediate scenarios.

The results of this scenario would be the connection of 1605 users as follows:

Table 6: Energy demand assessment under Future Scenario

| Type | Category | EDA (Wh/day) | Share | Number | Total EDA (Wh/day) |
|---|---|---|---|---|---|
| **Households** | basic | 550 | 58% | 746 | 410.300 |
| | medium | 1.650 | 37% | 475 | 783.750 |
| | high | 3.850 | 5% | 65 | 250.250 |
| **Commercial*** | basic | 550 | 25% | 73 | 40.150 |
| | medium | 1.650 | 65% | 188 | 310.200 |
| | high | 3.850 | 10% | 29 | 111.650 |
| **Community buildings** | basic | 1.100 | 67% | 2 | 2.200 |
| | medium | 1.100 | 0% | 0 | 0 |
| | high | 1.650 | 33% | 1 | 1.650 |
| **Education centres** | basic | 2.200 | 33% | 4 | 8.800 |
| | medium | 4.400 | 33% | 3 | 13.200 |
| | high | 7.150 | 33% | 3 | 21.450 |
| **Churches** | basic | 2.200 | 50% | 1 | 2.200 |
| | high | 7.700 | 50% | 1 | 7.700 |
| **Mosques** | basic | 1.100 | 67% | 2 | 2.200 |
| | medium | 1.100 | 0% | 0 | 0 |
| | high | 2.200 | 33% | 1 | 2.200 |

| Type | Category | EDA (Wh/day) | Share | Number | Total EDA (Wh/day) |
|---|---|---|---|---|---|
| **Wood processing factory** | basic | 150.000 | | 1 | 150.000 |
| **Health facilities** | basic | 16.500 | 100% | 1 | 16.500 |
| **Guesthouse** | basic | 0 | 100% | 1 | 88.000 |
| **Water Pump** | basic | 88.000 | 100% | 1 | 32.071 |
| **Telecom Towers** | basic | 32.071 | 100% | 1 | 53.350 |
| **Grain Mills** | basic | 53.350 | 50% | 2 | 4.400 |
| | high | 2.200 | 50% | 2 | 8.800 |
| **Market** | basic | 4.400 | 100% | 1 | 15.500 |
| **Street Lights** | basic | 15.500 | 100% | 1 | 42.840 |
| **TOTAL energy** | | | | | **2.379 kWh/day** |

Considering a 60% plant performance ratio and 6 peak sun-hours, the 2.379 kWh/day (868 MWh/year) would require a **661 kWp** PV plant.

With an emission factor of electricity production with gensets equal to 0.8 $kgCO_2eq./kWh$, the savings in greenhouse gas (GHG) emissions would be 694.773 $kgCO_2eq./year$, in case all demand would be covered by diesel generators.

The load curve for the future scenario is shown in Figure 11.

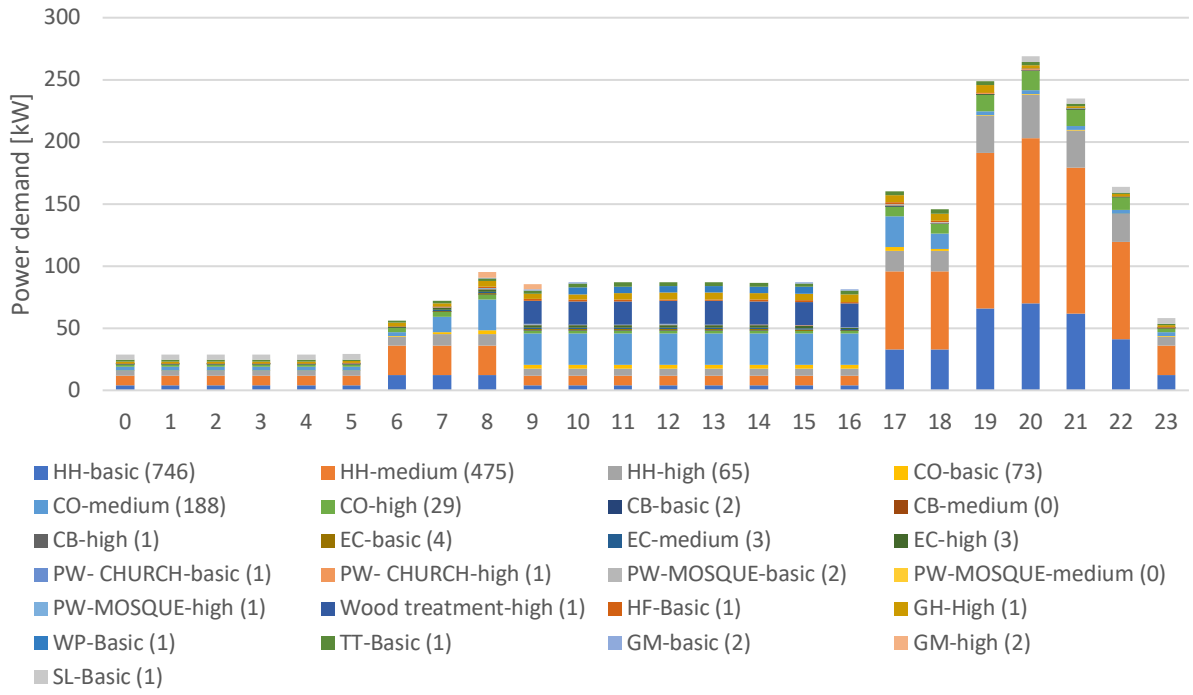


Figure 11: Bissorã load curve under Future Scenario

The load curve of the Future Scenario has higher night loads than the one of the Base and Intermediate Scenario, due to the fact that the residential consumption which peaks at night is higher than the commercial and institutional l loads (Figure 12).

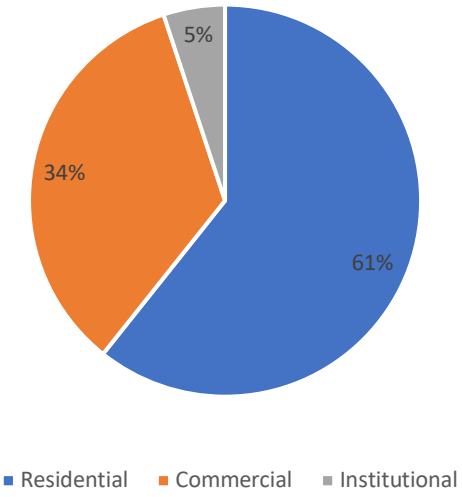


Figure 12: Pie chart of consumer types under Future Scenario

# 6. Conclusions

The energy baseline study considered various inputs of relevant projects in the country, in-house experience, as well as site visits in Bissorã in order to assess the potential of energy demand in the town. It was found that the 500 kWp installed of PV capacity are sufficient to cover, not only the demand of the initial 470 connections, but a total of more than 1300, depending on their size. Nonetheless, the distribution grid should be extended should a universal connection be opted for, since 24% of the population are physically excluded by the grid as it is at the moment.

Three scenarios were examined for the energy baseline taking into account the current number of energy meters, the possible number of connections in order to saturate the solar generation plant, as well as a future growth. The results of the three scenarios are summarised below.

Table 7: Summarised results of Energy Baseline

| | Base scenario | Intermediate scenario | Future scenario |
|---|---|---|---|
| **Connections** | 470 | 1.350 | 1.650 |
| **Daily demand** | 941 kWh/day | 1.799 kWh/day | 2.379 kWh/day |
| **Necessary PV capacity** | 261 kWp | 500 kWp | 661 kWp |
| **Emissions savings** | 274.743 kgCO2eq/year | 525.279 kgCO2eq/year | 694.773 kgCO2eq/year |

# Annex: Interview results

| | Name | Connection type | Neighbourhood | Current energy supply | Monthly income (CFA/month) | Actual electricity expenses (CFA/month) | Available electricity budget (CFA/month) | Seasonality | Current estimated demand (kWh/day) | Future demand - Desired (kWh/day) | Future demand - Adopted (kWh/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Sadja Camará | Utility | Joaquim N´kom | Shared genset (7 h/day) | 960.000 | 1.411.046 | 1.411.046 | Seasonal | 0,8 | 6,5 | 1,7 |
| **2** | Sene Camará | Commercial (MTN agent) | Praça-Mercado | Private genset (5.5 kVA, 10 h/day) | 534.500 | 270.000 | 349.000 | Seasonal | 20,8 | 21,4 | 21,4 |
| **3** | Guerra Bidonga | Community building (Regional Director of Agriculture) | Pecuaria | Shared genset (7 h/day) | 300.000 | 145.000 | 145.000 | Stable | 1,2 | 8,5 | 2,4 |
| **4** | Abu Camará | House | Joaquim N´kom | Shared genset (7 h/day) | 40.000 | 15.000 | 15.000 | Stable | 0,9 | 5,5 | 1,8 |
| **5** | Agostinho B.Indjalé | House | Madina | PV & batteries (24 h/day) | 60.000 | - | - | Seasonal | 2,1 | 5,3 | 4,1 |
| **6** | Alassam Djaló | Commercial (shop) | Praça-Mercado | Shared genset (5 h/day) | 210.000 | 20.000 | 20.000 | Stable | 2,4 | 2,8 | 2,8 |
| **7** | Alfa Umaro Bary | Commercial (shop) | Praça-Mercado | Shared genset (7 h/day) | 150.000 | 30.000 | 30.000 | Seasonal | 1,2 | 7,3 | 2,3 |
| **8** | Alfa Umaro Djalo | House | Santa Luzia | Batteries (5 h/day) | 130.000 | 15.000 | 15.000 | Seasonal | 1,2 | 7,6 | 2,4 |
| **9** | Aruna Camara | House | Sintcham | Private genset (5.5 kVA, 10 h/day) | 300.000 | 25.000 | 25.000 | Seasonal | 5,6 | 5,6 | 5,6 |
| **10** | Augusta Biambi | House | Gã-Djugudé | Private genset (2.5 kVA, 2 h/day) | 50.000 | 25.000 | 30.000 | Seasonal | 5,3 | 6,1 | 6,1 |

| | Name | Connection type | Neighbourhood | Current energy supply | Monthly income (CFA/month) | Actual electricity expenses (CFA/month) | Available electricity budget (CFA/month) | Seasonality | Current estimated demand (kWh/day) | Future demand - Desired (kWh/day) | Future demand - Adopted (kWh/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **11** | Bailo Ould Mohamed Ali Haidara | Commercial (shop) | Praça-Mercado | Shared genset (7 h/day) | 210.000 | 25.000 | 25.000 | Seasonal | 2,1 | 2,6 | 2,6 |
| **12** | Braima Camará | House | Braga | PV & batteries (7 h/day) | 70.000 | 25.000 | 25.000 | Seasonal | 9,3 | 9,7 | 9,7 |
| **13** | Braima Fati | House | Gã-Djugudé | Shared genset (7 h/day) | 42.000 | 33.000 | 33.000 | Seasonal | 0,8 | 3,9 | 1,5 |
| **14** | Abudo Pereira Bareto | Community building (Police) | Praça | Candles | - | 44.000 | 44.000 | Stable | 0,7 | 6,2 | 1,4 |
| **15** | Amadu Djau Djalo | Commercial (shop) | Praça | Shared genset (7 h/day) | 700.000 | 24.000 | 24.000 | Seasonal | 6,0 | 6,0 | 6,0 |
| **16** | Djibril Sidibe | Commercial (shop) | Santa Luzia | Shared genset (7 h/day) | 162.000 | 210.000 | 210.000 | Seasonal | 1,9 | 5,7 | 3,8 |
| **17** | Domengas M. S. Elena | House | Pecuaria | Shared genset (7 h/day) | 120.000 | 28.000 | 28.000 | Seasonal | 5,7 | 8,3 | 8,3 |
| **18** | Domingos Pereira | House | Braga | Shared genset (7 h/day) | 60.000 | 73.000 | 73.000 | Seasonal | 0,8 | 1,3 | 1,3 |
| **19** | Dumingos José Tchuda | House | Praça | Shared genset (8 h/day) | 60.000 | 150.000 | 150.000 | Seasonal | 4,4 | 5,6 | 5,6 |
| **20** | Eduardo Meuldo Barbosa sousa | House | Praça | Private genset (5.5 kVA, 8 h/day) | 80.000 | 88.000 | 88.000 | Seasonal | 9,8 | 9,9 | 9,9 |
| **21** | António Incude | Education centre (Liceu Regional de Bissorã) | Braga | Private genset (7 kVA, 4 h/day) | 800.000 | - | - | Seasonal | 6,9 | 13,5 | 13,5 |
| **22** | Alfa Conate | Commercial (Pharmacy) | Praça | Shared genset (7 h/day) | 300.000 | 2.000 | 2.000 | Seasonal | 1,5 | 5,9 | 2,9 |

| | Name | Connection type | Neighbourhood | Current energy supply | Monthly income (CFA/month) | Actual electricity expenses (CFA/month) | Available electricity budget (CFA/month) | Seasonality | Current estimated demand (kWh/day) | Future demand - Desired (kWh/day) | Future demand - Adopted (kWh/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **23** | Cumando Mané | Commercial (Pharmacy) | Joaquim N´kom | Shared genset (7 h/day) | 250.000 | - | - | Seasonal | 1,1 | 9,1 | 2,2 |
| **24** | Mamadu Samba Cunate | Commercial (Pharmacy) | Praça | PV & batteries (24 h/day) | 177.000 | 33.000 | 33.000 | Seasonal | 1,6 | 6,1 | 3,2 |
| **25** | Fatumata Cande | House | Praça Mercado | Shared genset (7 h/day) | 800.000 | 15.000 | 15.000 | Seasonal | 0,7 | 5,4 | 1,3 |
| **26** | Fernando Mané | House | Gã-Banana | Shared genset (4 h/day) | 25.000 | 3.000 | 3.000 | Stable | 1,5 | 14,4 | 3,0 |
| **27** | Doctor Nhina Na Tum-na | Health facilities (Hospital) | Joaquim N´kom | PV & batteries (3.25 kWp, 3 h/day) | 30.000 | 25.000 | 25.000 | Seasonal | 16,5 | 25,8 | 25,8 |
| **28** | Dauda Fino Camara | Hotel | Praça | Private genset (15 kVA, 12 h/day) | 600.000 | - | 25.000 | Seasonal | 87,5 | 89,1 | 89,1 |
| **29** | Sulemane Mane | Hotel | Gã-Banana | Private genset (40 kVA, 5 h/day) | 375.000 | - | - | Stable | 0,0 | 0,0 | 0,0 |
| **30** | Iaia Camará | House | Joaquim N´kom | Shared genset (7 h/day) | 50.000 | 33.000 | 33.000 | Seasonal | 3,2 | 9,4 | 6,5 |
| **31** | Augusta Biambi | Education centre (Instituto de Formação dos Professores) | Praça | Private genset (7 kVA, 5 h/day) | 2.712.500 | 11.800 | 11.800 | Seasonal | 2,2 | 2,6 | 2,6 |
| **32** | Clontente N´cada | Church | Praça | Private genset (15 kVA, 5 h/day) | 172.000 | 25.000 | 25.000 | Seasonal | 7,5 | 10,6 | 10,6 |
| **33** | Roberto Nhanque | Church | Joaquim N´kom | Private genset (2.5 | 308.000 | 25.000 | 25.000 | Seasonal | 1,8 | 5,8 | 3,7 |

| | Name | Connection type | Neighbourhood | Current energy supply | Monthly income (CFA/month) | Actual electricity expenses (CFA/month) | Available electricity budget (CFA/month) | Seasonality | Current estimated demand (kWh/day) | Future demand - Desired (kWh/day) | Future demand - Adopted (kWh/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | kVA, 4 h/day) | | | | | | | |
| **34** | Jamila Gomes Semedo | Education centre (Jardim Irmã Da Lena) | Joaquim N´kom | Private genset (5.5 kVA, 4 h/day) | 40.000 | 15.000 | 15.000 | Seasonal | 2,7 | 9,8 | 5,5 |
| **35** | João R. Cardoso | House | Praça | - | 125.000 | 25.000 | 25.000 | Seasonal | 6,6 | 7,8 | 7,8 |
| **36** | M´baque Camará | Commercial (shop) | Praça | Shared genset (7 h/day) | 180.000 | 15.000 | 15.000 | Seasonal | 0,9 | 3,0 | 1,7 |
| **37** | N´famara Camara | Commercial (shop) | Praça | Shared genset (7 h/day) | 500.000 | 15.000 | 15.000 | Seasonal | 5,4 | 5,4 | 5,4 |
| **38** | Malam Cisse | House | Joaquin N´KOM | Shared genset (7 h/day) | 65.000 | 15.000 | 15.000 | Seasonal | 2,8 | 4,1 | 4,1 |
| **39** | Mamado Djau Seide | House | Lolé | PV & batteries (24 h/day) | 60.000 | 15.000 | 20.000 | Seasonal | 1,0 | 3,1 | 2,0 |
| **40** | Mamadu Boi Djaló | House | Joaquim N´com | PV & batteries (24 h/day) | 166.000 | 71.000 | 71.000 | Seasonal | 1,8 | 10,1 | 3,6 |
| **41** | Mamasamba Djalo | Commercial (shop) | Praça | Shared genset (7 h/day) | 350.000 | 20.000 | 20.000 | Seasonal | 0,5 | 4,3 | 1,1 |
| **42** | Mariato Saide | House | Pecuaria | Candles | 50.000 | 15.000 | 15.000 | Seasonal | 2,3 | 4,3 | 4,3 |
| **43** | Aladje Mamadu Camara | Mosque | Santa-Luzia | Shared genset (3 h/day) | - | 15.000 | 15.000 | Seasonal | 1,7 | 3,0 | 3,0 |
| **44** | Queba Seide & Salam Camara Almames | Mosque | Argentina | Candles | 3.000 | 72.500 | 72.500 | Seasonal | 0,9 | 2,1 | 1,9 |
| **45** | Braima Cisse | Mosque | Santa-Luzia 2 | Outro | 5.400 | - | 0 | Seasonal | 0,6 | 1,4 | 1,1 |

| | Name | Connection type | Neighbourhood | Current energy supply | Monthly income (CFA/month) | Actual electricity expenses (CFA/month) | Available electricity budget (CFA/month) | Seasonality | Current estimated demand (kWh/day) | Future demand - Desired (kWh/day) | Future demand - Adopted (kWh/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **46** | Nilci Ramos | House | Gã-Banana | Portable light | 25.000 | 20.000 | 20.000 | Seasonal | 6,0 | 10,0 | 10,0 |
| **47** | Quintino Andji | Commercial (Stationer shop) | Praça | Private genset (5.5 kVA, 7 h/day) | 300.000 | 2.000 | 2.000 | Seasonal | 1,7 | 1,7 | 1,7 |
| **48** | Isnaba Embadji | Commercial (Stationer shop) | Praça | Private genset (5.5 kVA, 7 h/day) | 75.000 | 15.000 | 15.000 | Seasonal | 4,6 | 5,2 | 5,2 |
| **49** | Saido Dumbia | Commercial (Stationer shop) | Praça | PV & Shared genset (7 h/day) | 80.000 | - | - | Seasonal | 1,4 | 5,8 | 2,8 |
| **50** | Queba Seide | House | Joaquim N´kom | Shared genset (7 h/day) | 85.000 | - | - | Seasonal | 5,8 | 8,5 | 8,5 |
| **51** | Quemo Fati | Commercial (MTN agent) | Gâ-Banana | Private genset (7 kVA, 7 h/day) | 3.150.000 | 15.000 | 15.000 | Seasonal | 1,5 | 8,2 | 2,9 |
| **52** | Ricardo Dautarim Gomes Cacabra | Commercial (shop) | Praça | Private genset (7 kVA, 3 h/day) | 55.000 | 53.000 | 53.000 | Seasonal | 1,9 | 4,1 | 3,8 |
| **53** | Roberto Nhanque | House | Sintcham | PV & batteries (7 h/day) | 80.000 | 2.000 | 2.000 | Stable | 0,7 | 6,3 | 1,3 |
| **54** | Rucana Danfa | House | Braga | PV & batteries (24 h/day) | 80.000 | 5.000 | 5.000 | Seasonal | 3,0 | 4,3 | 4,3 |
| **55** | Seco Dembo | House | Joaquim N´kom | Portable light | 50.000 | 3.000 | 3.000 | Seasonal | 0,3 | 4,0 | 0,5 |
| **56** | Suleimane Djaló | Commercial (shop) | Praça | Private genset (2.5 kVA, 8 h/day) | 210.000 | 68.000 | 68.000 | Seasonal | 1,6 | 1,6 | 1,6 |

| | Name | Connection type | Neighbourhood | Current energy supply | Monthly income (CFA/month) | Actual electricity expenses (CFA/month) | Available electricity budget (CFA/month) | Seasonality | Current estimated demand (kWh/day) | Future demand - Desired (kWh/day) | Future demand - Adopted (kWh/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **57** | Tcherno Só | Commercial (shop) | Praça | Shared genset (7 h/day) | 500.000 | 25.000 | 25.000 | Seasonal | 0,5 | 2,3 | 1,1 |
| **58** | Tomas Pedro Vaz | Community building (Court) | praça | - | 600.000 | - | - | | 0,6 | 16,0 | 1,2 |
| **59** | ussuman marna | Wood saw | Lolé | Private genset | 335.000 | 35.000 | 25.000 | Seasonal | 3,5 | 7,9 | 7,1 |
| **60** | ussuman marna | House | Lolé | PV & batteries (24 h/day) | 300.000 | 3.000 | 3.000 | Seasonal | 0,2 | 0,6 | 0,3 |