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CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

INCEPTION MISSION REPORT

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and

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1. EXECUTIVE SUMMARY

2. INTRODUCTION

This document is the Inception Mission Report of the consultancy assignment developed by the contractor, Trama TecnoAmbiental (Spain), in *January 2013 in Chad*, for the CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS financed by UNIDO.

This was performed by the contractor in accordance with the contract and following the agreements rose with UNIDO.

According to the Contract, the assignment for the inception mission phase has these specific objectives:

Inception Mission Report which includes these two main points:

- Revised Final design proposal divided into two alternative price schedules against work.
- Work plan

Following this approach, the study methodology foresees an initial mission to Chad by the contractor's team who started in January the 13th and ended in February the 8th 2013.

During the mission the following staffs was present in Chad for the contractor:

- Matteo Briganti	Project coordinator
- Alex Pineau	Technical director
- Daniel Cadilla	PV expert and field engineer
- Gemma Querol	Community Development Specialist
- Abdelkhader Mahamat	Local Technical support and installation
- Baba Kerimba	Local Community Developer

During the first three days of the mission, in N´Djamena, meeting with the counterparts and other relevant actors were conducted as explained below:

Meeting 1, 14 January 2013

Attendant:

- Matteo Briganti	Project coordinator
- Alex Pineau	Technical director
- Gemma Querol	Community Development Specialist
- Abdelkhader Mahamat	Local Technical support and installation

Meeting 2, 14 January 2013

Attendant:

- Matteo Briganti	Project coordinator
- Alex Pineau	Technical director
- Gemma Querol	Community Development Specialist
- Abdelkhader Mahamat	Local Technical support and instalation
- Baba Kerimba	Local Community Developer

Meeting 3, 15 January 2013

Attendant:

- Abdelkerim Dangayemi — Project coordinator for the Ministry of Oil and Energy
- Moussa Idriss — Project coordination Assistant for the MEP
- Contractor's team

Meeting 4, 16 January 2013

Attendant:

- Mr. Adjid Mahamad (Director of Energy for the Ministry of Oil and Energy)
- Abdelkarim Dangayemi (Project coordinator for the Ministry of Oil and Energy)
- Contractor's team

Meeting 5, 16 January 2013

Attendant:

- Abdelkarim Dangayemi (Project coordinator for the Ministry of Oil and Energy)
- Contractor's team

3. SUMMARY OF THE PRELIMINARY FACTS

During the preliminary meetings, data gathering, mission organization and coordination, counterpart information and coordination as well as contractor´s team internal meeting for activities organization and coordination were performed. In particular the following subjects were carried out:

- Approach and methodology as well as activities performance strategy were illustrated and agreed with the counterpart.
- Discussions and clarifications on the project objectives and activities to be developed during the project.
- Discussions and clarifications on the available information on communities' structure, organization, economic and legal framework and appropriate direction of the future installation phase work plan and activities.

The first thing agreed was the work time plan which is resumed in the table below:

Field mission	14/01	15/01	16/01	17/01	18/01	19/01	20/01	21/01	22/01	23/01	24/01	25/01	26/01	27/01	28/01	29/01	30/01	31/01	01/02	02/02	03/02	04/02	05/02	06/02	07/02
N´Djamena	■	■	■																						
Douguia				■	■	■																			
Mombou							■	■	■																
N´Djamena										■	■														
Dourbali												■	■	■	■										
N´Djamena																■	■								
Guelendeng																		■	■	■					
Mailao																					■	■	■		
N´Djamena																								■	■

Figure 1 Time plane followed during the inception mission (source: TTA)

According to the methodology to be followed it was agreed during the meeting to follow the contractor´s recommendations which are reported in the chapter 3 and in particular it was underline that:

- The budget constraint of the project will force a strong reduction of the number and typology of the final users to be connected comparing to the study included in the TOR.
- The budget availability will potentially affect the sequence of the installation to be done.
- In order to achieve the proper reduction of energy demand to be covered a methodology of social-economic impact on the communities will be adopted, priorizing the users/activities which have a more positive impact on the communities themselves.
- The management model should be analysed together in order to guarantee the economic/operational sustainability of the service.
- The installation, management and operative framework of the service will be modelled preferably taking into account the involvement of the local communities.
- The tariff scheme should be specifically analysed for the rural electrification projects, object of this study, in order to guarantee the economic sustainability of the service.
- The particularly context of high level of energy demand growth in the concerned communities will have to be taken into account for the energy demand analysis.

4. METHODOLOGY

In this chapter it is reported on the methodology adopted by the contractor during the mission and shared with the counterpart and local team members, in order to performed the mission activities and achieve the objectives.

The main objective of the study is to select the potential final users to be connected to the micro grid as well as to analyse their energy demand in order to size the 5 systems.

For this purpose the following steps has been followed:

- Budget constraint adaptation to the context
- Preliminary data analysis
- Socio-economic study performance
- Technical demand analysis
- Final users priorization
- Economic sustainability guarantee (tariff fees selection study)

3.1 BUDGET CONSTRAINT

Accordingly to the contract signed with the client, the study has been conducted taking into account a first intermediate budget of about 1,200,000 USD and a second one which is the rest of the amount of money leaved to the final budget offered by the contractor in its tender proposal.

In resume the budget constraint is divided into two steps:

Budget Phase	Budget Amount (USD)
Phase I + Inception Mission Phase	1,200,000
Phase II	1,092,833
TOTAL	2,292,833

Table 2: Budget price schedule (source: TTA)

IMPORTANT: The study has been conducted accordingly to this budget. Therefore the technical solution proposed has been shaped to achieve the optimum scenario in terms of costs per service quality and accessibility.

3.2 DATA GATHERING

In order to collect the requested data available in the filed the contractor has count on a preliminary visit to the 5 villages, performed by the local partner before the contractor arrival in Chad. This was very helpful also in order to inform the 5 communities of the imminent arrival of the team. In this way the population, administrative centres, representants and commercial activities ´owner were well prepared to collaborate for the study.

The fact that the contractors local partner took part to the preliminary studies at the beginning of this project funding request were very helpful to collect the data in a short period and with high level results.

Technically speaking the data was collected mainly during the first three days in N´Djamena and during the all mission.

Along this period, the following information was collected:

- Census data up to 2009 (MEP)

- gross domestic product up to 2009 (MEP)
- Tax of demographic growth (MEP)
- Regional population distribution
- Electricity Tariff national scheme and framework
- Energy demand study for the 5 villages (2009) (Bureau d´Etude CCAG)
- *« carte électrique du Tchad horizon 2030 »* (MEP)

The information collected and the meetings and visits performed were helpful indeed for the contractor in order to have a clear vision of the work to be done and the future steps. Nevertheless the meteorological data requested were never provided. The contractor is still in stand-by for this. So the database available on internet has been used for this phase of the study.

In particular the solar irradiation data considered has been taken from PVGIS database.

3.3 SOCIAL AND ECONOMIC ANALYSIS

This chapter is dedicated to the methodology specifically shaped by the contractor in order to select those potential users which will have the maximum impact on the local communities in terms of social and economical aspects.

3.3.1 Objective of the Socioeconomic Study

The Socioeconomic study has been developed to analyze the social and economic components of the target population beneficiary of the project.

It has been applied in the five towns selected, which are Douguia, Mombou, Dourbali, Guelendeng and Mailao.

The main objectives of the study from a socio-economic point of view are:

1. Analysis of the 5 towns involved in the project
2. End Users prioritization
3. Definition of Development Indicators

Taking into consideration all the information and recommendations of the Terms of Reference (ToR), it was designed the Methodology of the Socioeconomic Study, which has been adapted on the field mission to Chad with some minor adjustments.

3.3.2 Principal Steps of the Socioeconomic Study

The working methodology applied for the study can be summarized in the following key steps:

- Documentary research, basically internet review and analysis of documents related to the country and the subject of the project
- Development of the working guide and data collection tools
- Meetings with key informants in N'Djamena
- Visit to the five towns involved in the project with several meetings with the authorities and the potential users

- Analysis of the information collected and final report with the end users prioritization and the proposal for development indicators.

3.3.3 Data Collection Instruments

The main instruments used for the data collection on the field visit were:

- **Interviews:** quantitative technique that involves an investigation conducted on a sample of subjects, representative of a wider group which takes place in the context of everyday life, using standardized interview procedures in order to obtain quantitative measurements on a large number of objective and subjective characteristics of the population.
- **Questionnaires:** there are the survey instruments and there are tools for collecting standardized data.
- **Focus Groups Discussions:** instrument to collect information from a group of people, encouraging discussion and debate for information consensus among all participants in the focus group, for which the facilitator guided questions that set the tone of the work in group, introducing new questions as the answers of the participants and each time it finds an area of interest for the project analysis.
- **Direct Observation:** This procedure was applied during the field visits when necessary to observe variables after the meetings with focus groups or individual persons.

When visiting each town, initial meetings were established with the local authorities and all the potential groups of consumers were contacted for the study.

All the meetings can be summarized in these main groups:

- Local authorities, traditional and governmental, in each one of the 5 towns involved in the project
- Potential Users through focus group discussions and individual meetings, depending on the context

3.3.4 Consumer Groups

The main groups of potential users according to the ToR were identified as follows:

- Public Services: public water supply systems, health centers, primary - secondary schools, religious buildings (Mosques – Churches) and other public buildings
- Income Generating Activities: water supply private stations, garages, restaurants, shops, Taylors, alimentation, mills, etc.
- Domestic Users: Some households were considered initially for the project although it was explicit in the ToR the need of major analysis.

And the different uses of the project generated power in the ToR were:

- Use for health centers and hospitals
- Use in the primary & secondary schools, hostels and teacher's quarters
- Use in the commercial activities like grinding mills, saloon, shops, etc.
- Water pumping
- Communications and computer centers
- Cottage industry, production units and local factories
- Domestic lighting and basic needs

During the field visit to Chad it was defined the Final Consumer Groups for the Socioeconomic study in order to be potential users of the new electricity system, always following the ToR, the prioritization of the Ministry of Energy and Petrol of Chad, the local authorities and the consumers' needs:

Consumer Groups

1. Water Supply Systems
2. Health centres
3. Education centres
4. Religious Centers (Mosques / Churches) and Community Centers
5. Telecommunications Towers
6. Associations / cooperatives / administrative buildings
7. Industrial activities and major consumers
8. Commercial activities
9. Entertainment and leisure activities
10. VIP and official houses
11. Street lighting
12. Family households

3.3.5 General Information analyzed for the socioeconomic study

General information was gathered from the meetings with the local authorities, traditional and governmental, and the important persons of the towns (notables, government representatives, religious leaders, ethnic chiefs, teachers, etc.) with the aim of improving the knowledge of the people living in the towns involved in the project.

The study was done together with a local contractor specialist in community development projects who has previous working experience in most of the towns.

Main issues of the information requested are:

- Information of the social structure of the towns
- Population, number of houses and compounds
- Growth rate *(according to the Government the growth rate in Chad is 3.5% for all the country)*
- Traditional leaderships
- Structure of local administration
- Family systems, identity and characteristics of social cohesion
- Status of women and gender empowerment
- Public services (water, health, education, etc.)
- Local organisms and associations
- Religious aspects
- Main business activities
- Community development plans
- Citizen security and vandalism
- Energy sources, current energy use and potential energy demand
- Operation and management of the new electricity system
- Involvement of the population during the construction period
- Willingness to pay for the services of electricity
- Availability of land for the placement of the photovoltaic central
- Collective and private ownership
- Project benefits for the community in different areas

3.3.6 Scoring System for Users Prioritization

An excel-based data tool has been developed for the study to entry information of each consumer group and be able to prioritize the final users.

Following the ToR, the prioritization of the Ministry of Energy and Petrol of Chad, the local authorities and the consumers' needs, the initial punctuation given to each group - named Factor 1 (F1) - is detailed as follows:

Nº	Consumer Group	Initial Punctuation (F1)
1	Water Supply Systems	100
2	Health centres	100
3	Education centres	90
4	Religious Centers (Mosques / Churches) and Community Centers	80
5	Telecommunications Towers	70
6	Associations / cooperatives / administrative buildings	70
7	Industrial activities and major consumers	60
8	Commercial activities	50
9	Entertainment and leisure activities	40
10	VIP and official houses	30
11	Street lighting	20
12	Family households	10

Table 3: Initial punctuation for potential users group (source: TTA)

Each Consumer Group has been analyzed individually in order to determine different parameters of the scoring system for the potential users belonging to each group, with three possible punctuations - Factor 2 (F2), in all the cases punctuation is 1, 2 or 3 - to allow a wide range of variation between the different groups of potential consumers. This factor was accurate on the field after the knowledge of the reality of the towns and its intrinsic characteristics.

Finally each parameter has been assigned with a weighting factor – Factor 3 (F3) - according to its relevancy to allow the homogeneity of all the Consumer Groups for the final prioritization table of each town.

According to this scoring system, the final punctuation for each potential user is:

$$X_i = F1_i * \Sigma (F2_i * F3_i)$$

A description of the parameters and factors used for each consumer group is detailed in the following section.

Water Supply Systems

ID	Parameter	F1	F2	F3
1.1	Nº of beneficiaries	100	% Population: >10% : 3 /1-10% : 2 / <1% : 1	0.20
1.2	Water Uses		Drinking 3 / Agriculture 2 / Industrial 1	0.12
1.3	Service Management		Public 3 / Community 2 / Private 1	0.14
1.4	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.15
1.5	Daily load profile		Day 3 / Mixed 2 / Night 1	0.12
1.6	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.12
1.7	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 4: Water supply punctuation (TTA)

Other information was asked to the potential users which could be interesting for the socioeconomic study but not scored for the socioeconomic prioritization:

- Nº of liters pumped per day
- Price per liter paid by users
- Management System
- Monthly Income level of the water supply system
- Potential benefits expected from the new energy system
- Monthly payment possibility

Health Centers

ID	Parameter	F1	F2	F3
2.1	Nº of patients		% Population: >10% : 3 /1-10% : 2 / <1% : 1	0.20
2.2	Service Management	100	Public 3 / Community 2 / Private 1	0.14
2.3	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.15
2.4	Equipment electricity needs		High 3 / medium 2 / low 1	0.12
2.5	Daily load profile		Day 3 / Mixed 2 / Night 1	0.12
2.6	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.12
2.7	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 5: health centre punctuation (TTA)

Additional Information not scored:

- Nº of medical staff
- Nº of rooms and offices
- Management System
- Potential benefits expected from the new energy system
- Monthly payment possibility

Education Centres:

ID	Parameter	F1	F2	F3
3.1	Nº of students		% town students >50% 3 /25-50% 2 / <25% 1	0.20
3.2	Service Management	90	Public 3 / Community 2 / Private 1	0.14
3.3	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.15
3.4	Equipment electricity needs		High 3 / medium 2 / low 1	0.12
3.5	Daily load profile		Day 3 / Mixed 2 / Night 1	0.12
3.6	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.12
3.7	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 6: education centers punctuation (TTA)

Additional Information not scored:

- Nº of teachers
- Nº of classrooms and offices
- Management System
- Potential benefits expected from the new energy system
- Monthly payment possibility

Religious Centers (Mosques / Churches) and Community Centers

ID	Parameter	F1	F2	F3
4.1	Nº of users		% Population: >10% : 3 /5-10% : 2 / <5% : 1	0.20
4.2	Training Center	80	Training 3 / no training 1	0.14
4.3	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.15
4.4	Equipment electricity needs		High 3 / medium 2 / low 1	0.12
4.5	Daily load profile		Day 3 / Mixed 2 / Night 1	0.12
4.6	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.12
4.7	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 7: religion and community centers punctuation (TTA)

Additional Information not scored:

- Nº of users
- Management System
- Potential benefits expected from the new energy system
- Monthly payment possibility

Telecommunications towers:

The technical team was in charge of the evaluation of the telecommunication towers. There is no information from the socioeconomic point of view.

Associations / Cooperatives / Administrative Buildings:

ID	Parameter	F1	F2	F3
6.1	Nº of beneficiaries / users		All population 3 / >15 members 2 / <15 mem. 1	0.20
6.2	Service Management		Public 3 / Community 2 / Private 1	0.14
6.3	Current Energy access	70	Generator 3 / Other systems 2 / Without 1	0.15
6.4	Equipment electricity needs		High 3 / medium 2 / low 1	0.12
6.5	Daily load profile		Day 3 / Mixed 2 / Night 1	0.12
6.6	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.12
6.7	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 8: Administrative buildings punctuation (TTA)

Additional Information not scored:

- Nº of rooms and offices /area
- Management System
- Potential benefits expected from the new energy system
- Monthly payment possibility

Industrial activities and major consumers

ID	Parameter	F1	F2	F3
7.1	Nº of workers	60	> 5 workers 3 / 3-4 work. 2 / 1-2 work. 1	0.20
7.2	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.20
7.3	Equipment electricity needs		High 3 / medium 2 / low 1	0.15
7.4	Daily load profile		Day 3 / Mixed 2 / Night 1	0.15
7.5	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.15
7.6	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 9: industrial activities punctuation (TTA)

Additional Information not scored:

- Management System
- Income, expense and benefit
- Potential benefits expected from the new energy system
- Monthly payment possibility

Commercial activities

ID	Parameter	F1	F2	F3
8.1	Nº of workers	50	> 5 workers 3 / 3-4 work. 2 / 1-2 work. 1	0.20
8.2	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.20
8.3	Equipment electricity needs		High 3 / medium 2 / low 1	0.15
8.4	Daily load profile		Day 3 / Mixed 2 / Night 1	0.15
8.5	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.15
8.6	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 10: commercial activities punctuation (TTA)

Additional Information not scored:

- Management System
- Income, expense and benefit
- Potential benefits expected from the new energy system
- Monthly payment possibility

Entertainment and leisure activities

ID	Parameter	F1	F2	F3
9.1	Nº of workers	40	> 5 workers 3 / 3-4 work. 2 / 1-2 work. 1	0.20
9.2	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.20
9.3	Equipment electricity needs		High 3 / medium 2 / low 1	0.15
9.4	Daily load profile		Day 3 / Mixed 2 / Night 1	0.15
9.5	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.15
9.6	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.15

Table 11: entertainment activities punctuation (TTA)

Additional Information not scored:

- Management System
- Income, expense and benefit
- Potential benefits expected from the new energy system
- Monthly payment possibility

VIP & Official Houses:

ID	Parameter	F1	F2	F3
10.1	Current Energy access	30	Generator 3 / Other systems 2 / Without 1	0.30
10.2	Daily load profile		Day 3 / Mixed 2 / Night 1	0.20
10.3	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.20
10.4	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.30

Table 12: Official houses punctuation (TTA)

Additional Information not scored:

- Family information
- Potential benefits expected from the new energy system
- Monthly payment possibility

Street Lighting:

ID	Parameter	F1	F2	F3
11.1	City Insecurity	20	High 3 / Medium 2 / Low 1	0.50
11.2	Current Energy access		Generator 3 / Other systems 2 / Without 1	0.50

Table 13: street lighting punctuation (TTA)

Additional Information not scored:

- Area to light up
- Interest of the administration and the population
- Potential benefits expected

Domestic households

ID	Parameter	F1	F2	F3
12.1	Current Energy access	10	Generator 3 / Other systems 2 / Without 1	0.30
12.2	Daily load profile		Day 3 / Mixed 2 / Night 1	0.20
12.3	Seasonal demand profile		Winter 3 / All year 2 / Summer 1	0.20
12.4	Monthly energy expenditure		> rate 3 / = rate 2 / < rate 1	0.30

Table 4: domestic household punctuation (TTA)

Additional Information not scored:

- Family information
- Potential benefits expected from the new energy system
- Monthly payment possibility

Although it was prepared a questionnaire and the prioritization system for the family households, it was not applied in most of the villages because this option was not possible.

The number of questionnaires done during the field visit is detailed in the following table. Some questionnaires have information of several users, but it has been counted as an individual questionnaire.

CONSUMER GROUP	Douguia	Mombou	Dourbali	Guelendeng	Maïlao
Authorities meetings	1	1	2	1	1
Water Supply Systems	1	1	4	2	-
Health centres	1	1	1	1	1
Education centres	2	2	1	3	3
Religious Centers (Mosques, Churches) and Community Centers	2	1	2	6	4
Telecommunications Towers	-	-	-	-	-
Associations / cooperatives / administrative buildings	8	4	7	13	5
Industrial activities and major consumers	2	1	4	2	-
Commercial activities	6	3	17	18	10
Entertainment and leisure activities	4	-	5	8	3
VIP and official houses	2	4	2	5	5
Street lighting	1	1	-	1	1
Family households	-	1	-	-	-
Total nº of questionnaires: 188	**30**	**20**	**45**	**60**	**33**

Table 14: questionnaire resume numbers (TTA)

3.3.7 Analysis of the Willingness to Pay

Once obtained the score of each potential user, a column has been added in the excel tool with the willingness to pay for the electric service observed during the field mission. This option has been defined with two options, **1** considering they can afford it and **0** if not, which eliminates the possibility of being considered as future user of the system.

Common exclusion criteria that have been used are:

- low capacity to pay for the new system, based on data obtained from monthly benefits and expenses
- low reliability of the data
- poor management of the resources
- temporary activities
- activities without a permanent establishment
- businesses that currently do not exist
- actual energy expenses much lower than the supposed with the new system
- no interest in being connected to the new electrical system

Administration buildings and VIP houses have been taken into account but this issue should be analyzed more thoroughly because it is unclear the willingness to pay.

3.4 ENERGY DEMAND ANALYSIS

For the energy demand analysis, it has been considered some criteria in order to decide whether to connect every single user.

The previous paragraph has explained which social and economic criteria had been used. From this result, a second filter with the energy demand analysis allowed us to add/remove user.

The first set of criteria is environmental with:

- The seasonal variation
- The irradiation data

The second set of criteria is geographic with the definition of a geographical area for some of the villages.

The third set of criteria is purely technical.

Differentiation between dry and rainy season

For the demand energy analysis it has been considered the two main Chadian seasons:

- Dry season from October till June
- Rainy season from July till September

For each season and each village, it has been estimated one load profile. Then, the sizing of the PV power plant would consider the worst load profile. See chapter 4.3 Demand analysis for the details.

Irradiation data

For the irradiation, it has been considered the worst case for the dry and rainy season for sizing purposes.

	Peak Sun Hour (PSH)	Comments
January	6,48	
February	6,73	
March	7,06	
April	6,79	
May	6,67	
June	6,20	Worst irradiation for dry season
July	5,70	
August	5,56	Worst irradiation for rainy season
September	6,28	
October	6,67	
November	6,55	
December	6,64	

Table 15: irradiation worse case per season (TTA)

Definition of a geographical area

In some villages, a geographical area has been defined between TTA and the ministry representative to reduce the area of the study due to economical and technical reasons. Dourbali, Guelendeng and Mailao have been affected by such a decision.

In Douguia and Mombou, the totality of the community has been defined has the geographical area of the study.

In Dourbali, the geographical area defined is limited by:

- the administrative district
- market district.

In Guelendeng, the geographical area defined is limited:

- For the part of N/S, the main road roundabout (south), the prefecture (north)
- 100 meters from the eastern side of the main road
- 400 meters from the west side of the main road

In Mailao, the geographical area defined is limited by

- For the part of N/S, the church (south), the market place (north)
- No restriction for the eastern side of the main road
- No restriction for the west side of the main road

Technical criteria

Some commercial activities such as mills, welding shop, telecom tower, water tower pumping and water filter shop has not been considered as final user due to high consumption.

Indeed, if it were include such high consumption users, the sizing of the PV power plants would have given a size of the PV generator too big given the budget available for each village. By removing these high consumption users, more small users can be connected to the PV power plant.

These aspects have been accepted by all, TTA and Ministry included

Some users have not been considered for other technical reason such as:

- distribution line distance (power loss, large section of cable)
- out of the defined geographical area
- unreliable straw bale construction
- the users which, because of a huge energy request, if connected would take a high percentage of the available PV capacity. This would determinate the exclusion of most of the other users.

3.5 FINAL USER PRIORIZATION

The final user priorization methodology is based on the merging of the results provided by the socio-economic analysis with the ones provided by the technical study.

In particular, the results of the socio-economic priorization gives as output the list of those users who have the higher socio-economic impact on the community and who are considered “reliable” under fee payment point of view. Those who are not reliable are marked as priority 0, at the end of the list.

Starting from this list all the potential users considered technically adequate has been selected.

An ultimate selection has been done accordingly to budget constraint consideration.

Therefore the final users' priorization list will give us the potential users to be connected to each micro-grid and who has been taken into account for systems sizing, including distribution lines, user internal line installation, etc.

In case the energy demand of the users includes in the list implicates a budget requirement higher than the limit considered, a finally re-definition of the list has been done in order to guarantee the higher quality of the service to the maximum number of priorized users.

3.6 ECONOMIC SUSTAINABILITY OF THE ELECTRICITY SERVICE

In this project when the contractor refers to economic sustainability it means that the incomes produced by the tariff fees collection are high enough to cover the costs faced by the operator for the O&M activities throughout the lifecycle of the micro-grid.

Specifically for this project the lifecycle of reference is about 10 years. This is because the tax of development of the visited community under economically and demographically point of view has been chosen at 3%/year accordingly to the data provided by the Ministry of Energy and Oil of Chad.

This has pushed the contractor to choose an energy future demand increasing factor about 3%/year which is too high to be applied on a 20 years life cycle basis.

The costs faced in this period by the operator, and so taken into account for the tariff fees selection, are manly three:

- Diesel costs for the backup generator
- O&M activities costs
- Reposition of the spare parts requested

Also it has been used as economic main parameters reference the following figure:

PARAMETERS	VALUE
DISCOUNT RATE	6,0%
INFLACTION	4,0%
GRANT FUND	100%
CAPITAL COSTS OWN COVERAGE	0%
FIRST YEAR OF EXERCISE	2014
LIFE CYCLE PERIOD	10

Table 16: Economic Parameters Hypothesis (TTA)

5. MAIN FACTS FINDINGS

In this chapter the most important aspects and issues encountered during the mission are reported. The facts included are the one that under social-economic, operative/logistical and technical point of view can have an impact on the following steps of the project, especially for the installation phase.

4.1 SOCIO ECONOMIC ANALYSIS

Main findings of the socio-economic study can be summarized in the following key points:

- Social conflicts can arise when there is not enough energy for all the population, even more when in the same area, not all the population has been selected. This issue takes more relevancy in the two towns with more population, Dourbali and Guelendeng, with high energy demand because they are commercial towns in its respective region.

- Administration buildings and VIP houses have been taken into account but this issue should be analyzed more thoroughly because it is unclear the willingness to pay.

- Douguia and Mombou seem to be the most organized towns in terms of grouping systems. They are well organized in different groups and used to work together. It could facilitate the implementation of the project to start in these two towns.

- Douguia, Mombou and Dourbali have more future plans to develop their commercial activities. There is more energy demand than actual needs to expand their businesses.

- Dourbali is participating in a construction project to extend the road from N'djamena. The area designated for this study will be affected by the extension and part of the current shops and houses will be demolished. This may affect negatively the project. Note that there will be a new public lighting on this road included in the road construction project and because of that, it has not been considered in the study. It is also necessary to consider the plans of the Ministry of Energy and Mines to construct in the future a thermal central in Dourbali.

- Guelendeng and Maïlao have more rental connections to generators than other towns, and they are really cheap. They don't pay too much for the service and it has been appreciated less willingness to pay for a better service than in the other towns. Especially in Maïlao this situation is more common among the businessmen. Also in these two towns more people showed less interest in the project.

- It will be necessary to ensure a proper management of the system through appropriate trainings and capacity building with the final users of the system to have a successful project.

- It was observed that many shops are rented. This issue should be taken into consideration during the next installation process since the owners were not contacted during the field mission.

- Safety measures should be considered to prevent thefts in the new energy system. Previous experiences in some towns show us that quite new buildings, which were equipped with solar panels (schools, health centers, etc.), batteries and solar panels, have been stolen and they do not work because the organizations didn't replace the stolen elements.

- All the five towns showed interest in collaborating with the project in some specific jobs (labor, loading and unloading material, transportation, the land for the plant, etc...) during the construction and installation phase of the project. It is necessary to consider that despite the good will, it is going to be more difficult in large towns than the small ones because the community organization is very different.

- With the aim to having a successful pilot project, it could be easiest start working in the smaller towns; social conflicts may arise and in the big towns it could be more difficult to manage them.

Benefits of the project in the five villages and how access to the new energy system can improve the life of the population, the commercial activities, education, etc. will be analyzed in the following section of development indicators.

In particular it has been dedicated a small paragraph for each of the villages.

4.1.1 Douguia

Douguia is a town of Hadjar Lamis state, 75 km north from Ndjamena. Its population is estimated around 4.000 inhabitants in the town center and 6.600 inhabitants counting the nearest villages around. It is a young town as it has a high level of young people among the population (40% are less than 15 years old) with a 52% of women and 48% of men. There are 492 houses within 288 building structures organized in compounds.

It is a touristic place as they have a big Centre Touristic - Hotel Resort, close to the river. It is a common place for the weekends, holidays and for conference meetings.

There are several ethnic groups living in Douguia and it is known as a Kotoko town, the main ethnic group and founder in 1947. Other majority ethnic groups are Ngambaye, Kanembou, Haussa, Sara, Born, Arabe and Zakawa.

It is embedded a traditional authorities system in Douguia. The chief of the village is always a Kotoko member and each ethnic group has its own representative, named the ethnic chief. The chief of the village is the representative in front of the administration authorities, which are based in another city. All the ethnic chiefs discuss together the main issues concerning Douguia and when there is any problem, they look for a solution by themselves without the involvement of the administrative authorities.

Each ethnic group has its own familiar systems and polygamy is common among Muslims. It is common that the man is the head of the family and women are usually consulted for family decisions but not for community issues. There are women associations that try to build community awareness for the women empowerment with the support of international organizations.

Most of the people follow the Muslim religion although there are some Catholics and Protestants.

The main occupation of Douguia population is the Agriculture; most of the families have its own land in the surroundings with corn, rice, beans, etc. The second occupation is the fishing followed by commercial activities. Finally, the animal husbandry is also very common.

Basic needs are covered with one primary and one secondary schools, one health center, public boreholes with manual pumps around the town and a community water supply system. All together have a positive effect on the population and it helps to improve the life conditions in Douguia.

Douguia has increased in number of inhabitants from the last five years because immigration from other villages and a higher birth rate. Annual population growth is estimated 3,5%.

There are several associations in Douguia: farmers, fishermen, women, commercial, health, education, etc., which means they are used to work in grouping systems.

In terms of energy resources and uses, at family level wood is the common resource used for cooking. Most of the families in Douguia have generator or a rent connection, and families are used to having expenses, like paying for the oil group or a monthly rental. Still is used for household lighting the oil and battery lamps although the most common nowadays are the battery ones. The big business and shops, mostly if they need electricity, they use generators for the electrical equipment. Alimentation shops and fish associations use oil refrigerators or they buy ice to keep the products fresh.

People are agreeing to participate during the construction period with manpower support for some works, donate construction materials like bricks, and the land for the photovoltaic central.

The Community would like to have a community management system for the new project. It is established for the Water Supply System and it is working properly.

4.1.2 Mombou

Mombou is the smallest town of the project, located in Kanem state. Its distance from the Capital city is 195 Km in the desert region of northwestern Chad. The settlement was established more than 160 years ago.

The neighborhoods considered in the project are “Mombou Grande” with 1.200 inhabitants and “Mombou Petite” with 800 inhabitants, with an average population of 60% women and 40% men. There are 337 houses and 117 compounds between Mombou Grande and Mombou Petit.

All the inhabitants are Muslims from the Konkon group, belonging to the Kanembou ethnic group, and their first language is the Kanembou with some Arabic speakers as a second language.

When problems arise in the village, among them they try to solve the problem, they do not use the structures of the state or the sultan, who lives in another village. Decisions are taken with the chiefs of each neighborhood village, notables, imams and the representatives of the associations.

Families are large and they practice the polygamy; man can have up to four wives. Within the family, decisions are taken in consultation with women.

Basic needs are covered with two primary schools (French and Arab systems), one health center and several manual pumps for water; public services that enhance quality of life and attract immigration to the town. There are two Koranic schools, one located in the main mosque and the other in the Arab school.

Mombou population has increased a lot during past years because the increase of births (more children per woman), more number of women per man and the increase of immigration from other villages.

There are different associations in Mombou, most of them leaded by ADIVIM, a big NGO in the village. We can find associations of agriculture producers, small shops, tontines (economic help groups between women), livestock faming, health, etc. Most of these associations are used to work with international NGOs and received funds for their projects (USAID, UE, FCIL, PAM, FOSAP, etc.).

People from Mombou are primarily farmers and stock breeders (goats, chickens, horses, etc.). Horticulture is developed in irrigated lands around the town with moto-pumps, and temporary agriculture within the rainy season, around 3 months per year, with millet and sorghum. Third main activity is the commerce, the traditional occupation of the population in Mombou. They use to buy and sell products in different places.

In terms of energy resources and uses, they use wood for cooking and at house level, oil and battery lamps. There are only 10 generators in Mombou Grande and Mombou Petit for commerce, lighting uses and television, and 8 moto-pumps for irrigation purposes.

They also prefer a community management of the new project and they would like to participate in project through manpower help, material transport, civil works, etc.

4.1.3 Dourbali

Dourbali is the biggest town of the project, located in Chari Baguirmi state, 95 km east from N’Djamena. Its population is estimated in 17.600 inhabitants. There are approximately 3.280 houses and 2.066 compounds.

The administrative structure consists in the sub prefecture, in charge of the administrative management of Dourbali and the villages around, and the City Hall in charge of the management of Dourbali town.

The traditional structure is represented by the canton chiefs, the most important traditional authorities, and the representatives of each ethnic group. Dourbali is mostly a Peuple town, the majority ethnic group and the founders, but there are also Arabe, Foulbe, Baguirmeri, Bourne, Hausa, Goran and Sara among others. The Foulbé Canton Chef is the Sultan of

Dourbali (before the establishment of the City Hall in 1999 he was the main responsible of Dourbali) and the second most important is the Baguirmeri Canton Chef. They work with the district responsible to organize the community issues. The notables have also an important role in the community management; they are consulted when problems arise, together with the Imam. In social issues, the City Hall doesn't participate.

As it is a big town, there are important public services allocated. There are two health centers and one district hospital, 5 primary and 2 secondary schools and 5 koranic centers. Two big water supply systems, one managed by the city hall and the other at community level, offer drinkable water to the population jointly with some private water producers.

Most of the people are Muslim, we can found 10 big mosques and 115 small (individual) in front of 2 churches. There are also animists among the population.

In terms of main activities, they are breeders, in commercial activities related with the small commerce and the animal husbandry, and farmers too. There are different associations of each main group.

The increase of inhabitants in Dourbali is related with the better life conditions in the town and immigration, attracted by the health centers and hospital, the water supply systems, agriculture production, commerce, etc.

Sources of Energy are similar to the other towns; wood for cooking and battery lamps are the most common sources of energy at household level. For commercial activities, generators are most common when it is possible.

They propose a community management system of the project, similar to the EU water supply system which works very well. As for community involvement in the project, people will be grouped in association and participate when possible.

Due to the large size of the village, it was delimited the area of the study, considering the two main areas where the administration and the commercial activities are concentrated.

4.1.4 Guelendeng

Guelendeng is the second largest town in the study, 153 km South from N'Djamena in Mayo Kebbi Est state, along the Chari River. It is part of the ancient Kingdom of Baguirmi (Baguirmi Sultanate) from the XVI century.

The population is estimated in 15000 inhabitants, 51% women and 49% men, with its 60% of population under 20 years old. There are 1900 compounds with an average of 2-3 houses per compound.

Guelendeng is the principal town of the Mayo Lemie department and because of that, it is the town with more administrative structures representatives of the project. It has Prefecture, Sub prefecture and the City Hall was established in 1998. The town has 12 districts, each one with a chief designated by the mayor (before it was designated by the Chief of the Canton, the traditional leader).

There are several ethnic groups, mainly Bornou, Sara, Massa, Ouaddai, Arabe, Kenembou, Gourane and Zakawa. The Chief of the Canton doesn't live in the town, he is 21 km away from Guelendeng. In the town there are 8 ethnic chiefs depending of the district chief.

The situation of women is similar to other towns; they are involved only in family decisions.

Population is mainly young because the birth rate is high. This reason, together with the immigration from rural areas to the town, is the principal reason of the population increase in Guelendeng.

Health services are covered by 1 district health center, 1 public health center and 1 private. Principal diseases are the predominance of malaria, respiratory infections and diarrhea diseases. Regarding education services, there are 9 primary schools and 4 secondary. One of the main problems in the city is the critical shortage of water. There were constructed 2 big tanks with its water supply systems in 1994, with 2 solar stations for pumping, but they are not working because of breakdowns not repaired. Hand pumps are used along the town

but the quality of the water is lower. A new water supply system is expected to be constructed in 2013.

Religious communities are Christians, Muslims and animists. We can find 15 mosques and 13 churches around Guelendeng.

Main sectors of occupation are agriculture, commerce (livestock, exportation, shopping, etc.) and fishing.

There isn't a public source of energy. Generators are used for some commercial activities and for lighting and house activities, the oil and battery lamps. For cooking only wood is used. There is a high energy demand.

A good management of the new electricity system is required, more even after the failure of the water projects.

The largest mosque, the Catholic Church and the cultural center are currently operating with solar panels. They are the only examples where these facilities are operating. The remaining cases observed (health center and schools) don't work because the material has been stolen.

Like in Dourbali, **because of the large size of the town, it was delimited the area of the study, considering the two main areas where the administration and the commercial activities are concentrated.**

4.1.5 Mailao

Maïlao is a town of the Chari Baguirmi state founded 80 years ago, 70 Km south from the Capital city. It has a population of 6500 inhabitants and 1460 houses within 480 compounds approximately.

Mailao is distributed throughout the main road crossing the town and most shops are located along the road.

There are different ethnic groups in Maïlao: baguirmens, boumon, foulbé, toupami, kim, massa, sara, kabalaye, kotoko, marba, etc. The chief of the town is named Blama and he is always from the Barguimeri ethnic group. He is the intermediary with the Canton chief, who lives in another town, and he is the responsible to deal with the sub prefecture, the administrative structure of the region. Sub-blama is like a district chief, and they manage the community problems with the Blama.

Regarding family systems and gender issues, the situation is similar to the other towns of the study.

Basic needs are covered with 1 health center, which is also the malnutrition center in the region, 3 primary schools (2 public and 1 private) and 1 public secondary school. There isn't a public water supply system in the town and the population use hand pumps.

Islam is the principal religion of the population, followed by Evangelical, Protestant and Catholic religions. Animism is also present. We can found 4 main mosque and 4 churches in Maïlao.

Main activities in the town are agriculture (raining season and horticulture with moto-pumps), fishing, commerce and livestock. There is a big open market on Sundays, with lot of people going to Maïlao from different places of the region. Several business and shops depend of this weekly market and its activity is not continuous.

Most of the associations created in Maïlao are informal, without legal status and they are not organized to work at grouping level. One of the big problems in the town is the lack of access to credit; but there is a credit cooperative in the town not working because creditors haven't been able to give back the money.

Energy Sources are similar to other towns at family level. In the commercial sector, it is common in Maïlao to have a sharing generator or pay a monthly rent for the connection, which is really cheap.

There was the experience of a solar panel system for the electricity in the secondary school, as it is a quite new building, but is not working because the material was stolen.

They would like to have a community management on the photovoltaic system, through an association, and physical participation in the installation and construction activities of the project.

4.2 DEMAND ANALYSIS

In this part, the load profile for each village is described. Each village has its own load profile because their size, geographical position and climate are different. As a result some village are more administrative, consuming energy during daytime, while other mixed administrative and commercial activities, consuming energy during day and night time.

Also it has been studied the difference between the dry and rainy season to determine which of both load profile is a worst case for the PV power plant sizing.

4.2.1 Douguia

Load profile brief description

The difference between the dry and rainy season load profile are the seasonal loads. In Douguia such loads are:

- 1 École (primary school)
- 1 Collège (secondary school)
- 1 Adduction d'eau potable (water tower pumping)

For Douguia, almost all the users inside the perimeter would be connected to the PV power plant except:

- some high consumption commercial activities such as mills, welding shop, telecom tower and water filter shop

Loads in Douguia are a mixed between administrative, commercial activities and private houses so that the load profile cannot be characterized as a daily or night load profile:

- At daytime, the PV power plant fed the administrative, public places (schools, health centre, church, mosque), association and commercial activities
- At night time (before midnight), the PV power plant fed the private houses, public places still opened (health centre, mosque) and commercial activities till midnight
- At night time (after midnight), the PV power plant fed the 24/7 loads, i.e. private fridge, health centre fridges, grocery fridge, association fridge (fishing), public lighting (till 02:00 am)

Load profile difference analysis between dry and rainy season

Load profiles do not present huge differences except at 04:00 pm where it can be observed a lower consumption in the rainy season than in the dry season. Indeed, there is no need to pump as much water during the rainy season and the three phase water pump hours of operation is reduced from 90 minutes to 60 minutes.

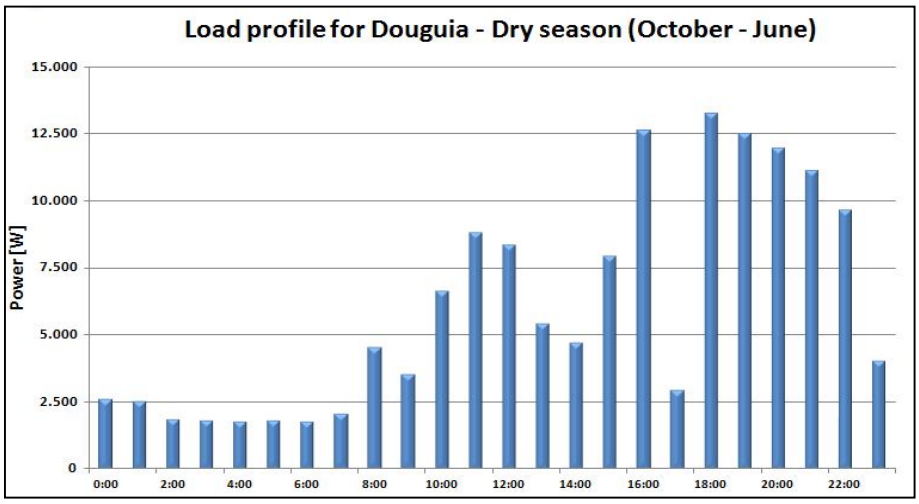


Figure 2: Load profile for Douguia (Dry Season) (TTA)

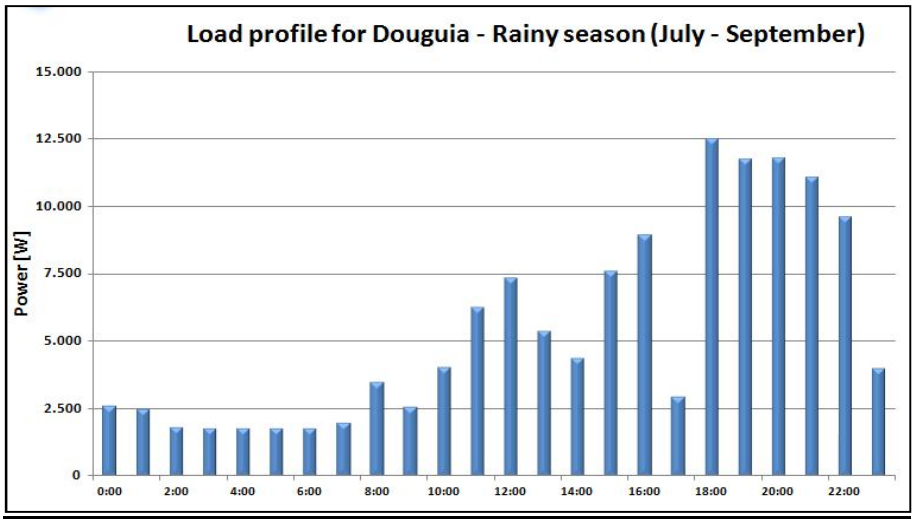


Figure 3: Load profile for Douguia (Rainy Season) (TTA)

Load profile: worst case

In terms of worst case for the PV power plant sizing, both load profile are similar. Load consumption is lower during rainy season than dry season but as the solar radiation is also lower, the calculated PV capacity, battery capacity and inverter power are in the same range.

Dry season, therefore, will be considered as the worst case.

	Dry season (Oct – Jun)	Rainy season (Jul – Sept)
Daily load demand	158,5 kWh/day	142,3 kWh/day
Peak Sun Hour	6,2 PSH	5,6 PSH
PV capacity at STC	42,6 kWp	42,6 kWp
Battery capacity at C100	8.006 Ah	7.805 Ah
Power peak at 30 minutes	13,2 kW	12,5 kW

Table 16: Load demand resume Douguia (TTA

4.2.2 Mombou

Load profile brief description

The difference between the dry and rainy season load profile are the seasonal loads. In Mombou such loads are:

- 1 École Primaire (primary school)
- 1 École Arabe (primary school)
- 1 Pompage d'eau pour irrigation (irrigation water pumping for market garden)

For Mombou, almost all the users would be connected to the PV power plant. In particular villager houses has been also included for this village as the small number of this type of users and their small energy demand allow to cover the demand without budget issues.

Loads in Mombou are mainly private houses. Few administrative institutions are represented due to the remote location of the village, at the entrance of Sahara desert. Commercial activities are also reduced. Mombou is a rural village and agriculture and livestock farming are the main activities. As a consequence, the load profile can be characterized as a night profile:

- At daytime, the PV power plant fed the few administrative, few public places (schools, health centre, mosque), association, and few commercial activities
- At night time (before midnight), the PV power plant fed the private houses, few public places still opened (health centre, mosque) and commercial activities till midnight
- At night time (after midnight), the PV power plant fed the 24/7 loads, i.e. grocery fridge, health centre fridges, public lighting (till 01:00 am)

Load profile difference analysis between dry and rainy season

Load profiles do present some relative differences during daytime. The difference comes from the irrigation water pumping for market garden. Indeed during the rainy season there is no need for irrigation whereas during the dry season the five water pumps (one phase, 1.5 kVA each) hours of operation reach up to 2,5 hours.

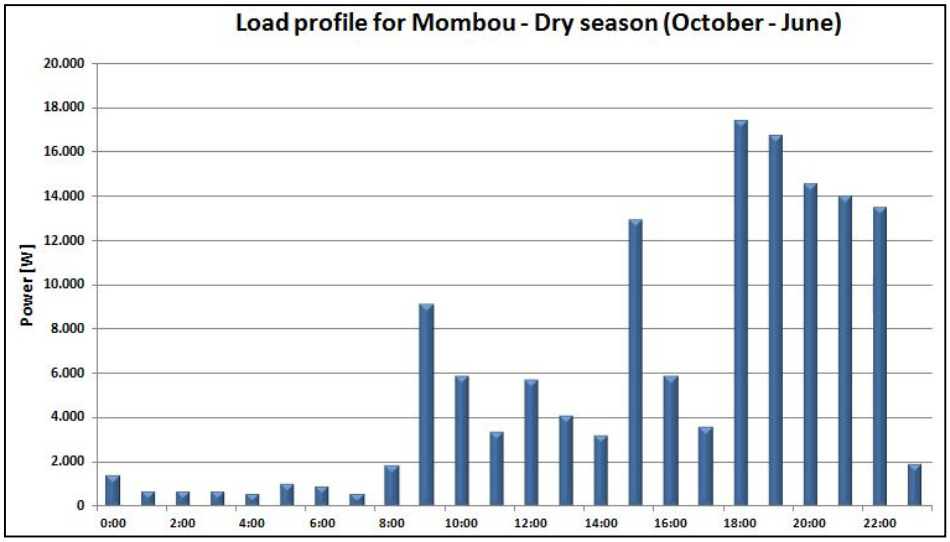


Figure 4: Load profile for Mombou (Dry Season) (TTA)

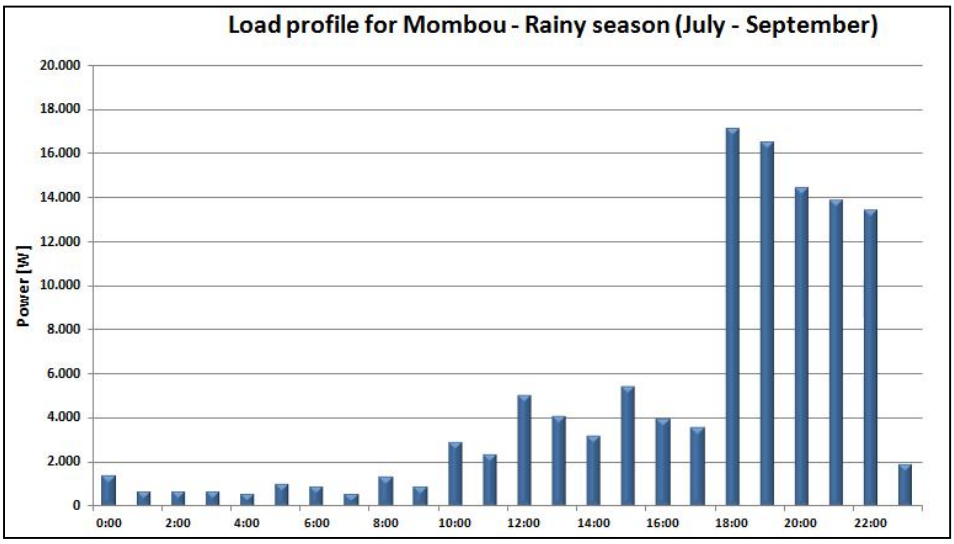


Figure 5: Load profile for Mombou (Rainy Season) (TTA)

Load profile: worst case

In terms of worst case for the PV power plant sizing, the dry season load profile has a significant higher consumption (irrigation water pumping). The higher solar radiation is not sufficient for compensation.

Dry season, therefore, will be considered as the worst case.

	Dry season (Oct – Jun)	Rainy season (Jul – Sept)
Daily load demand	153,6 kWh/day	127,7 kWh/day
Peak Sun Hour	6,2 PSH	5,6 PSH
PV capacity at STC	41,3 kWp	38,3 kWp
Battery capacity at C100	9.200 Ah	8.939 Ah
Power peak at 30 minutes	17,4 kW	17,1 kW

Table 17: Load demand resume Mombou (TTA)

4.2.3 Dourbali

Load profile brief description

The difference between the dry and rainy season load profile are the seasonal loads. In Dourbali such loads are:

- 1 École (primary school)

For Dourbali some category of users will not be connected to the PV power plant:

- some high consumption commercial activities such as mills, welding shop, telecom tower, water tower pumping and water filter shop

- some commercial activities such as shops, dressmaker, video game centre, bar dancing and restaurants for social and economical final user priorization
- Villager and VIP houses for social and economical final user priorization
- ONDR, Lycée (secondary school), small mosque, church for technical reasons such as distribution line distance or out of the defined perimeter

After the social and economical filter and the technical reasons, the loads to be connected in the PV power plant in Dourbali are mainly administrative institutions. Few private houses and few commercial activities are considered for the connection to the PV power plant. Indeed Dourbali is 15 000 inhabitants city and is a regional administrative centre with:

- Regional council (prefecture and sub prefecture)
- City council
- Police station
- Customs
- Law court

As a consequence, the load profile can be characterized as a daily profile:

- At daytime, the PV power plant fed the administrative, public places (schools, health centre, church, mosque), association and few commercial activities
- At night time (before midnight), the PV power plant fed commercial activities, public places still opened (health centre, mosque) and administrative (on duty)
- At night time (after midnight), the PV power plant fed the 24/7 loads, i.e. grocery fridge, health centre fridges

Load profile difference analysis between dry and rainy season

Load profiles do not present huge differences; only one primary school is considered as a seasonal load and represents a daily consumption of 8.5 kWh/day distributed from 08:00 am to 01:00 pm (primary school) and from 06:00 pm to 09:00 pm (alphabetization course).

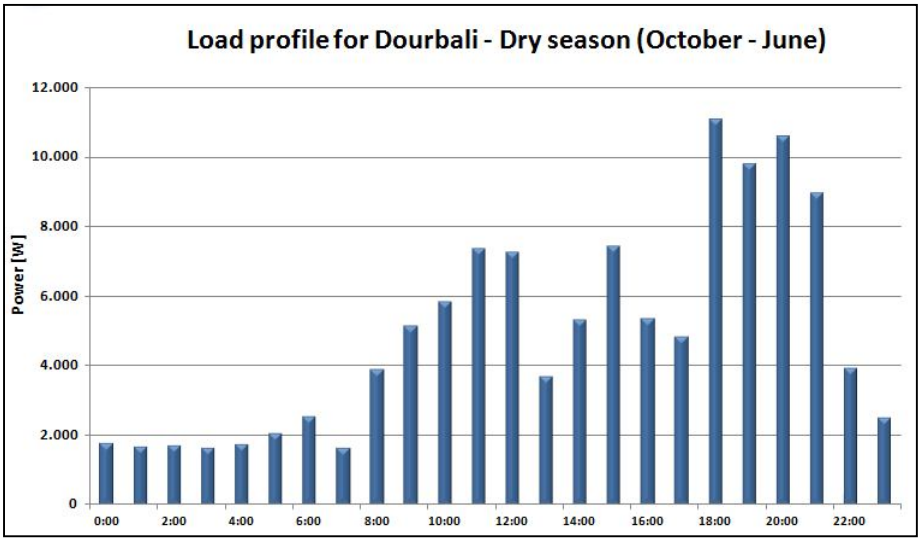


Figure 6: Load profile for Dourbali (Dry Season) (TTA)

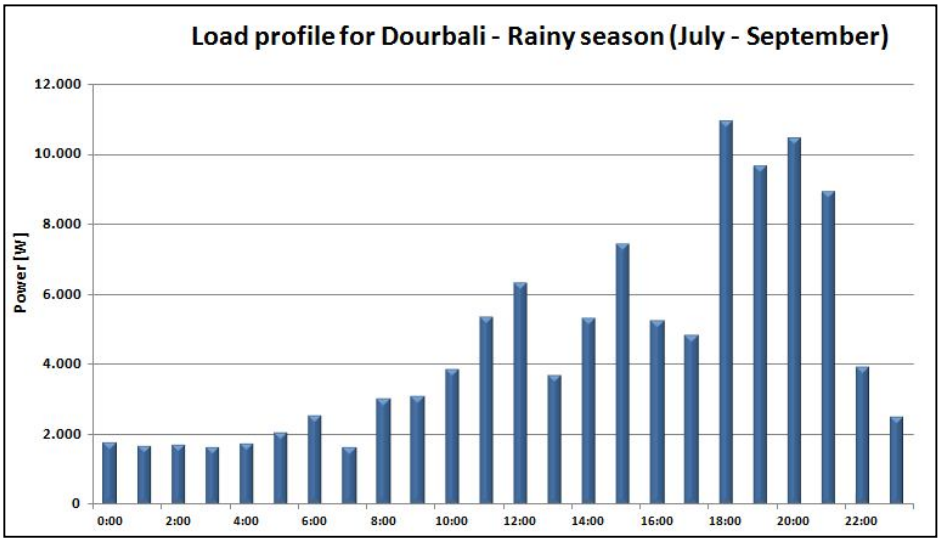


Figure 7: Load profile for Dourbali (Rainy Season) (TTA)

Load profile: worst case

In terms of worst case for the PV power plant sizing, the dry season load profile has a slightly higher consumption (primary school) that the higher solar radiation is sufficient for compensation. Somewhat more battery capacity is needed due to night alphabetization course as well as inverter power.

Dry season, therefore, will be considered as the worst case.

	Dry season (Oct – Jun)	Rainy season (Jul – Sept)
Daily load demand	129,5 kWh/day	120,2 kWh/day
Peak Sun Hour	6,2 PSH	5,6 PSH
PV capacity at STC	35,0 kWp	36,0 kWp
Battery capacity at C100	7.046 Ah	6.988 Ah
Power peak at 30 minutes	11,1 kW	10,9 kW

Table 18: Load demand resume Dourbali (TTA)

4.2.4 Guelendeng

Load profile brief description

The difference between the dry and rainy season load profile are the seasonal loads. In Guelendeng such loads are:

- 1 Collège + Lycée (primary and secondary school)
- 1 École centre B (primary schools)
- 1 École privée + college (primary and secondary school)
- 1 École Martawa (primary school)
- 1 Bureau inspecteur education (Academic area inspector)

For Guelendeng some category of users will not be connected to the PV power plant:

- some high consumption commercial activities such as mills, welding shop, telecom tower and ice machine
- almost all of the commercial activities for social and economical final user priorization. Only the hairdresser and printing shops are still considered
- Villager and VIP houses for social and economical final user priorization
- Some churches, mosque and association for technical reasons such as distribution line distance or out of the defined perimeter

After the social and economical filter and the technical reasons, the loads to be connected in the PV power plant in Guelendeng are mainly administrative institutions. No private houses are considered whereas few commercial (hairdressers and printing shop) would be connected. Indeed Guelendeng is 15 000 inhabitants city and is a regional administrative centre with:

- Regional council (prefecture and sub prefecture)
- City council
- Police station
- Customs

As a consequence, the load profile can be characterized as a daily profile:

- At daytime, the PV power plant fed the administrative, public places (schools, health centre, church, mosque) and few commercial activities
- At night time (before midnight), the PV power plant fed commercial activities, public places still opened (health centre, mosque) and administrative (on duty)
- At night time (after midnight), the PV power plant fed the 24/7 loads, i.e. grocery fridge, health centre fridges, public lighting (till 02:00 am)

Load profile difference analysis between dry and rainy season

Load profiles do present some relative differences during daytime. The difference comes from the primary and secondary schools that are closed during the rainy season. These 5 schools altogether with the academic area inspector represent a consumption of about 30 kWh/day.

Because the schools have 100% daily profile:

- the needed capacity battery is identical for the dry and rainy season
- the needed inverter capacity at 30 minutes is much higher during the dry season than the rainy season. Indeed schools are using fans, computers, small printers and lighting which increase the power needed

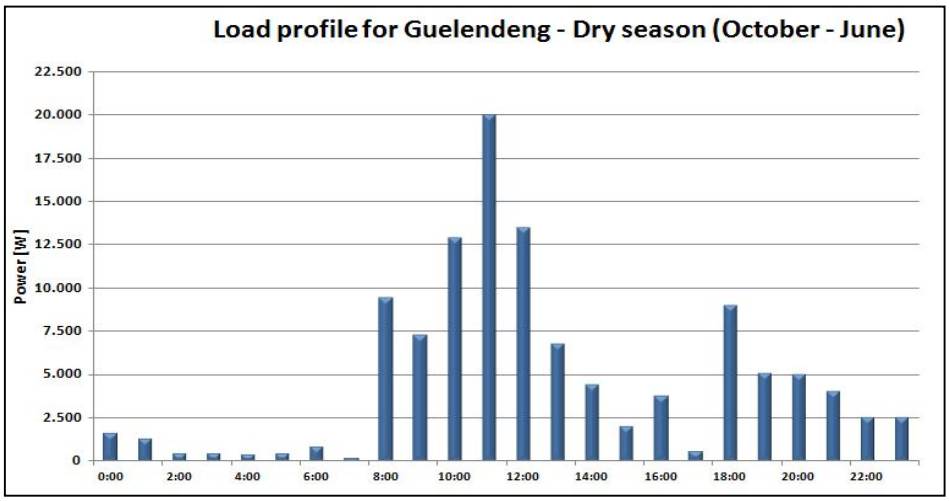


Figure 8: Load profile for Guelendeng (Dry Season) (TTA)

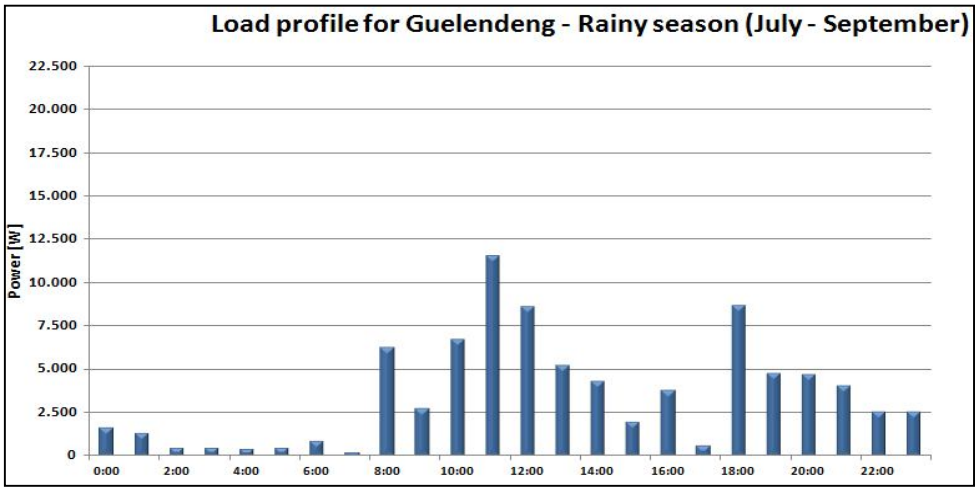


Figure 9: Load profile for Guelendeng (Rainy Season) (TTA)

Load profile: worst case

In terms of worst case for the PV power plant sizing, the dry season load profile has a significant higher consumption (irrigation water pumping) that the higher solar radiation is not sufficient for compensation.

Dry season, therefore, will be considered as the worst case.

	Dry season (Oct – Jun)	Rainy season (Jul – Sept)
Daily load demand	125,6 kWh/day	92,6 kWh/day
Peak Sun Hour	6,2 PSH	5,6 PSH
PV capacity at STC	33,8 kWp	27,8 kWp
Battery capacity at C100	3.717 Ah	3.626 Ah
Power peak at 30 minutes	20,0 kW	11,5 kW

Table 19: Load demand resume Guelendeng (TTA)

4.2.5 Mailao

Load profile brief description

The difference between the dry and rainy season load profile are the seasonal loads. In Guelendeng such loads are:

- 1 École - centre A (primary schools)
- 1 Lycée + École – centre B (primary and secondary school)
- 1 École catholique (primary school)
- 3 Jardins maraichers individuels (irrigation water pumping for individual market garden)

For Mailao some category of users will not be connected to the PV power plant:

- some high consumption commercial activities such as mills, welding shop and telecom tower
- some commercial activities such as shops where only lighting is required. Indeed most of the shop are located along the road and public lighting will be installed
- Villager and VIP houses for social and economical final user priorization
- Some mosque and association for technical reasons such as distribution line distance or out of the defined perimeter

After the social and economical filter and the technical reasons, the loads to be connected in the PV power plant in Mailao are mainly a mixed between administrative institutions and commercial activities (grocery shop, dressmaker, mobile phone charger, hairdresser, video club, bar dancing and video game shop). No private houses are considered.

As a consequence, the load profile can be characterized as a mixed daily and nigh load profile:

- At daytime, the PV power plant fed the administrative, public places (schools, health centre, church, mosque), association and commercial activities
- At night time (before midnight), the PV power plant fed the private houses and commercial activities till midnight
- At night time (after midnight), the PV power plant fed the 24/7 loads, i.e. private fridge, health centre fridges, grocery fridge, association fridge (fishing), public lighting (till 02:00 am)

Load profile difference analysis between dry and rainy season

Load profiles do present some relative differences during daytime. The difference comes from the schools (that are closed during the rainy season) and the irrigation water pumping for individual market garden (no need to irrigate during the rainy season). The 3 schools and the irrigation water pumping represent a consumption of about 12 kWh/day and 18 kWh/day respectively.

Because the schools and the irrigation water pumping have 100% daily profile:

- the needed capacity battery is identical for the dry and rainy season
- the needed inverter capacity at 30 minutes is much higher during the dry season than the rainy season. Indeed schools are using fans, computers, small printers and lighting which increase the power needed. Each market garden used one water pumps (one phase, 1.5 kVA) which hours of operation reach up to 4 hours/day

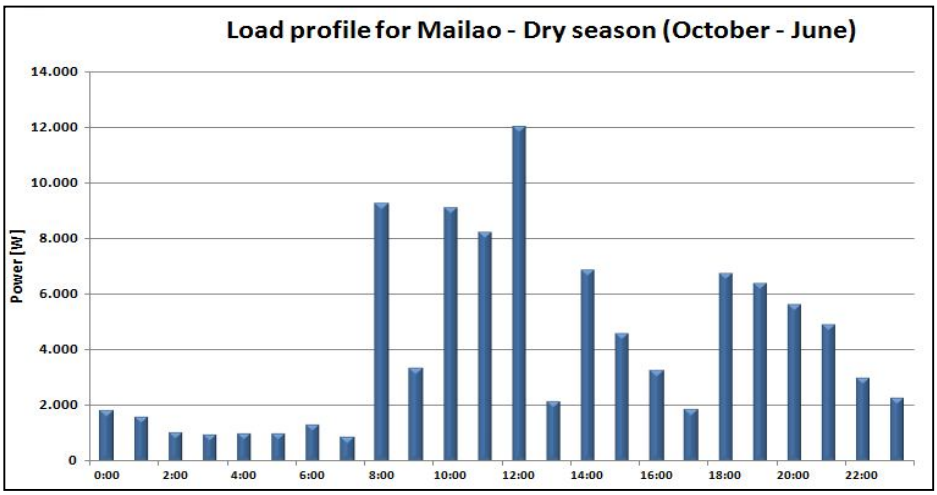


Figure 10: Load profile for Mailao (Dry Season) (TTA)

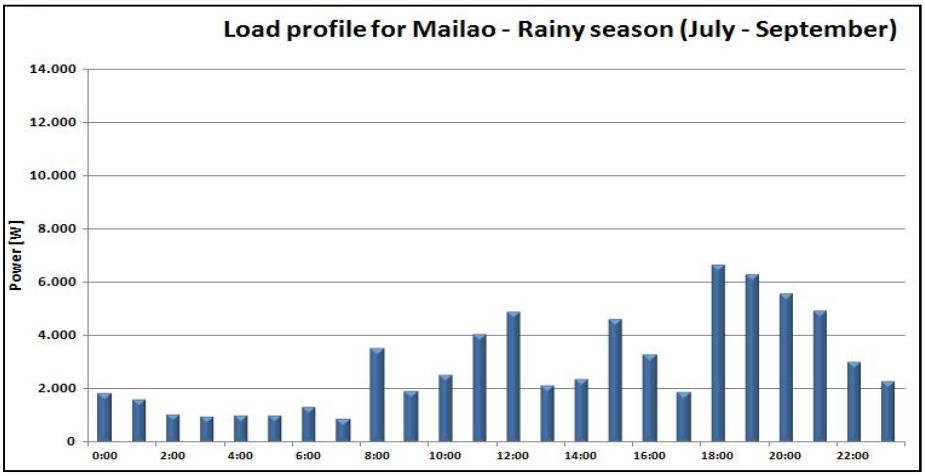


Figure 11: Load profile for Mailao (Rainy Season) (TTA)

Load profile: worst case

In terms of worst case for the PV power plant sizing, the dry season load profile has a significant higher consumption (irrigation water pumping) that the higher solar radiation is not sufficient for compensation.

Dry season, therefore, will be considered as the worst case.

	Dry season (Oct – Jun)	Rainy season (Jul – Sept)
Daily load demand	109,76 kWh/day	76,5 kWh/day
Peak Sun Hour	6,2 PSH	5,6 PSH
PV capacity at STC	29,5 kWp	22,9 kWp
Battery capacity at C100	4.307 Ah	4.275 Ah
Power peak at 30 minutes	12,1 kW	6,7 kW

Table 20: Load demand resume Mailao (TTA)

4.3 PARTICULAR IMPORTANT FACT ENCONTERED

The purpose of this part is to highlight the main themes and basic facts encountered during the five villages field visit. These encountered facts have been agreed between TTA and the Ministry.

4.3.1 Douguia

For the location of the PV generator, it was selected a field next to the school and the central market. This location is appropriate to give a value to the structure of the PV generator, type pergola with solar panels to 4 feet above the ground, so that traders and / or population can benefit from a shaded area. A study will be carried out within this framework.

Turning to the loads, the water pump used in the water tower is a three phase submerged water pump. All the other loads in the village are single phase, so particular attention has been done when designing the distribution line to bring three phase power to the water power.

4.3.2 Mombou

For the location of the PV generator, the field has been selected in accordance with the community: close to the market place and the public square that serves as a meeting point between the two districts Mombou Grand and Mombou Petit. This location is appropriate to give a value to the structure of the PV generator, type pergola, for traders and / or population can benefit from a shaded area for commercial activities and / or community. A study will be carried out within this framework.

The community is divided into several districts with are distant one from each other's. As part of this project, only two districts are considered: Mombou Grand and Mombou Petit. These two districts are distant of about 1 kilometre and represent the main administrative, commercial and agricultural activities of the whole community.

The project of the European Community of water supply has not yet started its implementation phase. It will not be considered in the project.

The market gardens located in the surroundings of the village are actually using a direct moto-pump for irrigation. However and in order to smooth the energy demand, a water tank is planned to be installed. Indeed, with a PV power plant, it is better to spread the hour of pumping in order to not overload the inverters. Furthermore, Mombou load profile is a night load profile, so training must be done for the farmers to pump preferably during the day.

Turning to the topology proposed in Mombou with two independent distribution line, it is important distributing equally the loads because both the central and distributes system would have the same PV and battery capacity and the same rated inverter power @ 30min.

4.3.3 Dourbali

For the location of the PV generator, it was not possible to find a space that is within the market area in the middle of the commercial activities. The selected location is in the administrative part of the city, next to the sub-prefecture. The better site would have been the market place but this area is a private ownership.

In Dourbali, there is a project to build wider roads within the perimeter considered in the study. On a practical level, this means that users located on these roads or streets will be moved between 4 and 6 meters from their current location. In addition, uncertainty about the date of execution is a serious problem to decide whether to include these users in the project. Actually these users represent a significant percentage of the load demand of about 50-70%.

According to the representatives of the Ministry there is also a high probability that Dourbali would be selected in the framework of a national electrification project in the short / medium term. The national electrification project is spread over time until 2030, but Dourbali has a high priority in this program.

4.3.4 Guelendeng

For the location of PV generator, it was decided two possible sites:

- A field next to the ONDR, near the administrative
- A field in the commercial area

Indeed, the administrative and commercial districts are quite distant from each other and it has been considered the possibility to install:

- a single PV power plant with large distribution line
- Two independent PV power plant with shorter distribution line

Result of the study showed that it is more economical to build a single PV power plant and the location of the PV generator would be within the commercial area. Thus a single distribution line will be installed and will provide electricity to both the administrative and commercial district.

4.3.5 Mailao

There are some markets gardens along the main roads but there are too distant from the village and consume too much energy to be connected to the PV power plant. They will not be considered in the final list.

On the contrary it has been decided to include some individual garden as they are closer to the village centre and furthermore they are a good example of potential commercial development to be support with PV generated electricity.

6. STUDY RESULTS

This chapter reports on the requested output obtained with the study as well as proposed solution to issues faced.

5.1 PHASE I AND PHASE II COMMUNITY IDENTIFICATION

In this chapter the contractor face the important aspect of the selection of the communities to be included under the budget step 1 (1,200,000 USD) and under the step 2.

In this document the contractor refers to PHASE I as the phase under the budget step 1 and PHASE II accordingly.

Taking into account the fact finding during the mission, which are explained in the chapter above, the contractor proposal for this division is the following:

PHASE	COMMUNITY
I	Douguia, Mombou
II	Dourbali, Guelendeng, Mailao

Table 21: Budget steps phase definition (TTA)

The proposal has been shared with the Ministry representative and accepted. The reason for this decision are schematically reported here below:

- Douguia and Mombou are relatively small villages and fits to the budget constraint of the first phase.
- The users are mostly concentrated (except isolated cases). This gives the possibility to cover all the most

- Important users, accordingly to the followed methodology. No users curtail for budget has been applied in PHASE I.
- For these reasons they are the optimum choice for showing the impact that rural electrification project can have on social-economic aspects of the communities.
- The two villages are on the same geographic area.

In particular Dourbali was initially indicated as the priority one village but it was decided to put it in the second phase especially for the following reasons:

- A diesel generation based grid is provided in the short term. The MEP has been asked to provide more details on this aspect.
- The construction of new main streets interests the perimeter concerned by the study. This means that the streets themselves will be wider and so a high percentage of the potential users selected will be moved. The costs of users place reconstruction is on the users ´shoulders, so the timing of reconstruction is very uncertain.
- The gap between the budget availability and the technical solution requested by this huge city push the contractor to recommend a project redefinition.

Also Guelendeng it has been identify as a potential trouble community in terms of discrepancy between the budget constraint and the energy demand. The Ministry representative also commented that a re-designing of the project should be taken into account for this community as well.

5.2 PROPOSED USERS PRIORIZATION LIST

Using the methodology explained in chapter 3.4 the table shown below have been obtained.

It is interesting to check the five central columns where the different steps of the methodology can be followed:

Step1: socio-economic score

Step 2: willingness to pay (payment reliability)

Step 3: technical score

Step 4: budget constraint limitation

The white cell has been used in order to quickly identify the potential users selected.

5.2.1 Douguia

Final Users	Ut.	Social economic Priority (Punctuacion)	Payment Reliability (0/1)	Punctuacion tecnica (0/1)	Punctuacion FINAL	Budget constraint selection	FRAC.BAT T.	Assigned Tariff (Txy)	Monthlee Fee	EDA (Wh/dia)	Aggregate EDA	Pot max. (W)	Aggregate Pot. Max.	Conectados (1=si; 0=no)
Adduction d'eau potable	1	290	1	1	290	1	0,53	T820	28531,8	4400	4400	10	10	1
Centre de Santé	1	246	1	1	246	1	0,73	T92	32098,275	4950	9350	1	11	1
Ecole	1	183,6	1	1	183,6	1	0,54	T105	35664,75	5500	14850	2,5	13,5	1
Grande Mosquée	1	177,6	1	1	177,6	1	0,68	T73	24965,325	3850	18700	1,5	15	1
Gendarmerie	1	176,4	1	1	176,4	1	0,77	T31	10699,425	1650	20350	0,5	15,5	1
Collège	1	165,6	1	1	165,6	1	0,90	T105	35664,75	5500	25850	2,5	18	1
Bureau de Douane	1	162,4	1	1	162,4	1	0,82	T42	14265,9	2200	28050	1	1	1
ONDR	1	142,8	1	1	142,8	1	0,63	T53	17832,375	2750	30800	1,5	2,5	1
Coiffeur	2	125	1	1	125	1	0,80	T21	7132,95	2200	33000	1	3,5	1
Tailleur Grande	3	125	1	1	125	1	0,59	T21	7132,95	3300	36300	1,5	5	1
Groupement APCL-NOKAR / ALWIHIDA /yaourts	1	117,6	1	1	117,6	1	0,69	T73	24965,325	3850	40150	1,5	6,5	1
Groupement KYEE	1	117,6	1	1	117,6	1	0,65	T93	32098,275	4950	45100	1,5	8	1
Chargeur de batterie téléphone	3	115	1	1	115	1	0,76	T21	7132,95	3300	48400	1,5	9,5	1
Alimentation	5	115	1	1	115	1	0,71	T82	28531,8	22000	70400	5	14,5	1
Groupement APCL-NOKAR / ALWIHIDA /yaourts	1	110	1	1	110	1	0,69	T73	24965,325	3850	74250	1,5	16	1
Cine club privé grande	1	102	1	1	102	1	0,95	T62	21398,85	3300	77550	1	17	1
Boutique Grande	8	100	1	1	100	1	0,79	T11	3566,475	4400	81950	4	21	1
Cine club privé petit	2	100	1	1	100	1	0,95	T62	21398,85	6600	88550	2	23	1
Tailleur Petit	5	82,5	1	1	82,5	1	0,59	T21	7132,95	5500	94050	2,5	25,5	1
Ménage Infermier	1	60	1	1	60	1	0,85	T41	14265,9	2200	96250	0,5	26	1
Ménage Directeur ONRD	1	60	1	1	60	1	0,76	T72	24965,325	3850	100100	1	27	1
Ménage Directeur Adjoint et Formateur ONRD	1	60	1	1	60	1	0,76	T72	24965,325	3850	103950	1	28	1
Ménage Chef du Village	1	51	1	1	51	1	0,83	T51	17832,375	2750	106700	0,5	28,5	1
Ménage du Iman	1	51	1	1	51	1	0,75	T72	24965,325	3850	110550	1	29,5	1
Ménage du Directeur de l'École	1	51	1	1	51	1	0,76	T72	24965,325	3850	114400	1	30,5	1
Ménage du Pateur x 2	2	51	1	1	51	1	0,83	T51	17832,375	5500	119900	1	31,5	1
Ménage Chef d'Ethnie x 6	6	51	1	1	51	1	0,83	T51	17832,375	16500	136400	3	34,5	1
Éclairage Public	1	30	1	1	30	1	1,00	T102	35664,75	5500	141900	1	35,5	1
Atelier de Soudure	1	171	1	0	0	1	0,51	T2012	71329,5	0	141900	0	35,5	0
HOTEL - niveau bas d'occupation	3	162	1	0	0	1	0,70	T2020	71329,5	0	141900	0	35,5	0
Moulin grande	1	159	0	0	0	1	0,50	T113	39231,225	0	141900	0	35,5	0
Moulins petits	9	147	0	0	0	1	0,50	T113	39231,225	0	141900	0	35,5	0
Usine de filtrage d´eau	1	138	1	0	0	1	0,50	T134	46364,175	0	141900	0	35,5	0
Petite Mosquée	1	125,6	1	0	0	1	0,67	T31	10699,425	0	141900	0	35,5	0
Grillade de Viande	5	105	0	0	0	1	1,00	T11	3566,475	0	141900	0	35,5	0
Groupement APCL-NOKAR / ALWIHIDA /yaourts	1	103,6	0	0	0	1	0,69	T73	24965,325	0	141900	0	35,5	0
Boutique - Station de Carburant	3	100	1	0	0	1	1,00	T11	3566,475	0	141900	0	35,5	0
Église Catholique	1	97,6	0	0	0	1	0,73	T21	7132,95	0	141900	0	35,5	0
Boutique Petite	7	82,5	0	1	0	1	0,79	T11	3566,475	0	141900	0	35,5	0
Bar Dancing	2	80	0	0	0	1	0,97	T51	17832,375	0	141900	0	35,5	0
Magasin	56	0	1	0	0	1	1,00	T11	3566,475		141900		35,5	0
Antenne TLC	2	0	1	0		1	0,51	T2016	71329,5	0	141900	0	35,5	0

Table 22: Final users 'list Douguia (TTA)

Number of users selected for Douguia: 54

5.2.2 Mombou

Final Users	Ut.	Social economic Priority (Punctuacion)	Willingness to Pay vs Tariff assigned (0/1)	Punctuacion tecnica (0/1)	Punctuacion FINAL	Budget constraint selection	FRAC.BATT.	Assigned Tariff (Txy)	Monthlee Fee	EDA (Wh/dia)	Aggregate EDA	Pot max. (W)	Aggregate Pot. Max.	Conectados (1=si; 0=no)
Centre de Santé	1	231	1	1	231	1	0,73	T92	32098	4950	4950	1	1	1
École Primaire	1	183,6	1	1	183,6	1	0,53	T51	17832	2750	7700	0,5	1,5	1
Pompage d'eau pour irrigation	5	177,8	1	1	177,8	1	0,40	T73	24965	19250	26950	7,5	9	1
Bureau Association ADIVIM	1	175	1	1	175	1	0,79	T54	17832	2750	29700	2	11	1
École Arabe	1	166,5	1	1	166,5	1	0,53	T41	14266	2200	31900	0,5	11,5	1
Grande Mosquée	1	141,6	1	1	141,6	1	0,66	T42	14266	2200	34100	1	12,5	1
Groupement de femmes - Boutique	2	130,9	1	1	130,9	1	0,68	T11	3566	1100	35200	1	13,5	1
Chargeur de batterie téléphone	3	122,5	1	1	122,5	1	0,73	T21	7133	3300	38500	1,5	15	1
Petite Mosquée	1	109,6	1	1	109,6	1	0,67	T21	7133	1100	39600	0,5	15,5	1
Alimentation	2	107,5	1	1	107,5	1	0,70	T82	28532	8800	48400	2	17,5	1
Atélier Électronique	1	100	1	1	100	1	0,62	T11	3566	550	48950	0,5	18	1
Tailleur	2	97,5	1	1	97,5	1	0,60	T21	7133	2200	51150	1	19	1
Garage	1	96	1	1	96	1	0,53	T63	21399	3300	54450	1,5	20,5	1
Ménage President ADIVIM	1	60	1	1	60	1	0,74	T62	21399	3300	57750	1	21,5	1
Ménage Infermier	1	60	1	1	60	1	0,76	T72	24965	3850	61600	1	22,5	1
Ménage du Iman	2	60	1	1	60	1	0,80	T41	14266	4400	66000	1	23,5	1
Ménage Directeur École Arabe	1	51	1	1	51	1	0,81	T51	17832	2750	68750	0,5	24	1
Menage Presidents Tontine	2	36	1	1	36	1	0,76	T11	3566	1100	69850	1	25	1
Ménage Chef du Village	2	36	1	1	36	1	0,76	T41	14266	4400	74250	1	26	1
Éclairage Public	1	30	1	1	30	1	1,00	T102	35665	5500	79750	1	27	1
Ménage à faible revenu	107	17	1	1	17	1	0,95	T11	3566	58850	138600	53,5	80,5	1
Moulin	1	171	1	0	0	1	0,50	T113	39231	0	138600	0	80,5	0
Ménage Maitre Assistant École Français	1	60	0	1	0	1	0,76	T41	14266	0	138600	0	80,5	0
Ménage du Directeur de l'École Français	1	42	0	1	0	1	0,80	T41	14266	0	138600	0	80,5	0

Table 23: Final users 'list Mombou (TTA)

Number of users selected for Mombou: 138

5.2.3 Dourbali

Final User Type	Final Users (NOMBRE DEFINITIVO)	Ut.	Social economic Priority (Punctuacion)	Willingness to Pay vs Tariff assigned (0/1)	Punctuacion tecnica (0/1)	Punctuacion FINAL	Budget constraint selection	FRAC.BATT.	Assigned Tariff (Txy)	Monthlee Fee	EDA (Wh/dia)	Aggregate EDA	Pot max. (W)	Aggregate Pot. Max.	Conectados (1=si; 0=no)
	Centre de Santé	1	231	1	1	231	1	0,67814096	T82	28531,8	4400	4400	1	1	1
	Ecole	1	183,6	1	1	183,6	1	0,575387621	T143	49930,65	7700	12100	1,5	2,5	1
	Grande Mosquée	1	165,6	1	1	165,6	1	0,62761444	T114	39231,225	6050	18150	2	4,5	1
	Mairie	1	151,2	1	1	151,2	1	0,535699374	T32	10699,425	1650	19800	1	5,5	1
	Sous-Prefecture	1	151,2	1	1	151,2	1	0,556457565	T32	10699,425	1650	21450	1	6,5	1
	Bureau de Douane	1	134,4	1	1	134,4	1	0,636512262	T31	10699,425	1650	23100	0,5	7	1
	Gendarmerie - Groupement Mobile	1	134,4	1	1	134,4	1	0,82099872	T31	10699,425	1650	24750	0,5	7,5	1
	Securité Nationale	1	134,4	1	1	134,4	1	0,774358974	T21	7132,95	1100	25850	0,5	8	1
	Centre Social	1	128,8	1	1	128,8	1	0,529686641	T32	10699,425	1650	27500	1	9	1
	Gendarmerie - Brigade Dourbali	1	126	1	1	126	1	0,834775374	T31	10699,425	1650	29150	0,5	9,5	1
	Palais de Justice	1	126	1	1	126	1	0,616839585	T44	14265,9	2200	31350	2	11,5	1
	Commissariat de police	1	126	1	1	126	1	0,728125	T31	10699,425	1650	33000	0,5	12	1
	Chargeur de batterie téléphone	28	115	1	1	115	1	0,758064516	T21	7132,95	30800	63800	0,5	12,5	1
	Pharmacie grande	2	100	1	1	100	1	0,732347328	T51	17832,375	5500	69300	0,5	13	1
	Adduction d'eau potable - Projet UE	1	270	0	0	0	1	0,505626442	T2020	71329,5	0	69300	0	13	0
	Producteurs d'eau privés	2	230	1	0	0	1	0,4	T205	71329,5	0	69300	0	13	0
	Fabrique eau minerale	1	159	1	0	0	1	0,500789959	T195	67763,025	0	69300	0	13	0
Se reunen muy poco	Association APESS	1	156,1	0	0	0	1				0	69300		13	0
	Usine de fabrication de glace	1	150	1	0	0	1	0,502475904	T208	71329,5	0	69300	0	13	0
	Atelier de Soudure Petit	4	147	1	0	0	1	0,511578306	T2012	71329,5	0	69300	0	13	0
	Atelier de Soudure Grande	1	129	1	0	0	1	0,511578306	T2012	71329,5	0	69300	0	13	0
	Ancienne grande Mosquée	1	128	0	1	0	1	0,679144385	T31	10699,425	0	69300	0	13	0
	Atelier de Menusierie	1	127,5	0	1	0	1	0,543577982	T72	24965,325	0	69300	0	13	0
	Alimentation Grande	1	125	1	1	0	0	0,708554857	T82	28531,8	0	69300	1	14	0
	Cine club privé grande	2	125	1	1	0	0	0,948009748	T62	21398,85	0	69300	1	15	0
	Coiffeur Grande	5	122,5	1	1	0	0	0,80349345	T21	7132,95	0	69300	0,5	15,5	0
	Atélier Électronique	1	117,5	1	1	0	0	0,620481928	T11	3566,475	0	69300	0,5	16	0
	Alimentation Petite	8	115	1	1	0	0	0,708554857	T82	28531,8	0	69300	1	17	0
Quitado yo	Coiffeur Petite	5	115	1	1	0	0	0,80349345	T21	7132,95	0	69300	0,5	17,5	0
Quitado yo	Discothèque Grande	3	115	1	1	0	0	0,711009174	T41	14265,9	0	69300	0,5	18	0
Quitado yo	Tailleur	19	112,5	1	1	0	0	0,59478673	T21	7132,95	0	69300	0,5	18,5	0
Se reunen muy poco	Association ISTIFAK		102,2	0	0	0	1				0	69300		18,5	0
Quitado yo	Cine club privé petit	2	94	1	1	0	0	0,948009748	T62	21398,85	0	69300	1	19,5	0
Quitado yo	Pharmacie Petite	1	92,5	1	1	0	0	0,921641791	T11	3566,475	0	69300	0,5	20	0
Quitado yo	Petite Mosquée	1	88	1	1	0	0	0,679144385	T31	10699,425	0	69300	0,5	20,5	0
Quitado yo	Restaurant Grande	3	88	1	1	0	0	0,721105528	T82	28531,8	0	69300	1	21,5	0
	Restaurant Petit	1	88	0	1	0	1	0,721105528	T82	28531,8	0	69300	0	21,5	0
Quitado yo	Ménage Maire	1	84	1	0	0	0	0,811538462	T82	28531,8	0	69300	0	21,5	0
Quitado yo	Veterinaire	1	81,5	1	1	0	0	0,709627329	T82	28531,8	0	69300	1	22,5	0
Quitado yo	Salle de Jeux	1	80	1	1	0	0	0,719917012	T21	7132,95	0	69300	0,5	23	0
Quitado yo	Discothèque Petite	1	80	1	1	0	0	0,711009174	T41	14265,9	0	69300	0,5	23,5	0
Quitado yo	Boutique Grande	25	77,5	1	1	0	0	0,791237113	T11	3566,475	0	69300	12,5	36	0
Quitado yo	Boutique Petite	7	75	1	1	0	0	0,791237113	T11	3566,475	0	69300	3,5	39,5	0
Quitado yo	Boutique - Station de Carburant	3	75	1	1	0	0	1	T11	3566,475	0	69300	1,5	41	0
Quitado yo	Ménage Sousprefet	1	72	1	1	0	0	0,837560976	T42	14265,9	0	69300	1	42	0
no encuestas	Grillade de Viande	10	52	1	1	0	0	1	T11	3566,475	0	69300	5	47	0
Quitado yo	Ménage Chef de Canton	3	36	1	1	0	0	0,817919075	T82	28531,8	0	69300	3	50	0
Quitado yo	Ménage Chef Quartier	2	36	1	1	0	0	0,787644788	T31	10699,425	0	69300	1	51	0
Quitado yo	Ménage Comandant Gendarmerie - Groupeme	1	36	1	1	0	0	0,763520157	T83	28531,8	0	69300	1,5	52,5	0
Quitado yo	Ménage du Iman	1	36	1	1	0	0	0,817919075	T82	28531,8	0	69300	1	53,5	0
Quitado yo	Ménage Representant Grand Sultan	1	36	1	1	0	0	0,747115385	T62	21398,85	0	69300	1	54,5	0
	Ménage Chef Ass. Eau	1	36	1	0	0	1		T21	7132,95	0	69300	0	54,5	0
	ONDR	1	0	1	0	0	1	0,634813499	T53	17832,375	0	69300	0	54,5	0
sin encuestas	Bar Dancing	1	0	0	0	0	1	0,966084275	T51	17832,375	0	69300	0	54,5	0
	Antenne TLC	1	0	0	0	0	1		T2016	71329,5	0	69300	0	54,5	0
no fichas(fuera)	Collège	1	0	0	0	0	1	0,575387621	T143	49930,65	0	69300	0	54,5	0
carrettera a reformar	Éclairage Public	1	0	0	0	0	1	1	T152	53497,125	0	69300	0	54,5	0
Fuera perimetro	Église	2	0	0	0	0	1	0,727745665	T21	7132,95	0	69300	0	54,5	0
no fichas(fuera)	Lycée	1	0	0	0	0	1	0,575387621	T143	49930,65	0	69300	0	54,5	0
sin encuestas	Moulin	17			0	0	1	0,504754358	T113	39231,225	0	69300	0	54,5	0

Table 24: Final users 'list Dourbali (TTA)

Number of users selected for Dourbali: 42

5.2.4 Guelendeng

Final Users (NOMBRE DEFINITIVO)	Ut.	Social economic Priority (Punctuacion)	Willingness to Pay vs Tariff assigned (0/1)	Punctuacion tecnica (0/1)	Punctuacion FINAL	Budget constraint selection	FRAC.BATT.	Assigned Tariff (Txy)	Monthlee Fee	EDA (Wh/dia)	Aggregate EDA	Pot max. (W)	Aggregate Pot. Max.	Conectados (1=si; 0=no)
Centre de Santé	1	261	1	1	261	1	0,688714012	T103	35664,8	5500	5500	1,5	1,5	1
Adduction d'eau privée - pompe monophase	3	250	1	1	250	1	0,4	T76	24965,3	11550	17050	9	10,5	1
Collège + Lycée	1	183,6	1	1	183,6	1	0,617898145	T173	60630,1	9350	26400	1,5	12	1
Prefecture	1	182,7	1	1	182,7	1	0,732635787	T126	42797,7	6600	33000	3	15	1
Église Martawa ACT Protestant	1	177,6	1	1	177,6	1	0,729182879	T21	7133,0	1100	34100	0,5	15,5	1
Mairie	1	172,2	1	1	172,2	1	0,52718601	T42	14265,9	2200	36300	1	16,5	1
Église Evangelique	1	171,2	1	1	171,2	1	0,654987634	T52	17832,4	2750	39050	1	17,5	1
Ecole Centre B	1	165,6	1	1	165,6	1	0,532919631	T113	39231,2	6050	45100	1,5	19	1
Bureau de Douane	1	155,4	1	1	155,4	1	0,625714286	T31	10699,4	1650	46750	0,5	19,5	1
Bureau Inspector Education	1	154,8	1	1	154,8	1	0,519502868	T51	17832,4	2750	49500	0,5	20	1
Grande Mosquée	1	153,6	1	1	153,6	1	0,671621622	T42	14265,9	2200	51700	1	21	1
ONDR	1	151,2	1	1	151,2	1	0,579082774	T31	10699,4	1650	53350	0,5	21,5	1
Centre Culturel	1	147,2	1	1	147,2	1	0,681016949	T55	17832,4	2750	56100	2,5	24	1
Sous-Prefecture	1	142,8	1	1	142,8	1	0,74126025	T74	24965,3	3850	59950	2	26	1
Petite Mosquée	1	137,6	1	1	137,6	1	0,673151751	T21	7133,0	1100	61050	0,5	26,5	1
Brigade Nomade	1	134,4	1	1	134,4	1	0,734383954	T21	7133,0	1100	62150	0,5	27	1
Brigade ST (Police)	1	134,4	1	1	134,4	1	0,674883721	T21	7133,0	1100	63250	0,5	27,5	1
Gendarmerie - Brigade Dourbali	1	134,4	1	1	134,4	1	0,852895753	T31	10699,4	1650	64900	0,5	28	1
Commissariat de police	1	134,4	1	1	134,4	1	0,593931398	T31	10699,4	1650	66550	0,5	28,5	1
Groupement PVV	2	127,4	1	1	127,4	1	0,70990991	T11	3566,5	1100	67650	1	29,5	1
Église EFLT	1	125,6	1	1	125,6	1	0,729182879	T21	7133,0	1100	68750	0,5	30	1
École privée + Collège	4	125	1	1	125	1	0,719251337	T53	17832,4	11000	79750	6	36	1
Ecole Martawa	1	122,4	1	1	122,4	1	0,580694006	T133	46364,2	7150	86900	1,5	37,5	1
Éclairage Public	1	122,4	1	1	122,4	1	0,537037037	T72	24965,3	3850	90750	1	38,5	1
Imprimerie grande	5	115	1	1	0	0	0,80349345	T21	7133,0	0	90750	2,5	41	0
Coiffeur	1	30	1	1	0	0	1	T152	53497,1	0	90750	1	42	0
Tailleur	11	115	1	1	0	0	0,59478673	T21	7133,0	0,0	90750	5,5	47,5	0
Chargeur de batterie téléphone	38	115	1	1	0	0	0,74137931	T21	7133,0	0,0	90750	19	66,5	0
Station carburant 1	1	135	1	1	0	0	0,856770833	T207	71329,5	0,0	90750	3,5	70	0
Station carburant 2	1	135	1	1	0	0	0,8861264	T2017	71329,5	0,0	90750	8,5	78,5	0
Alimentation	22	115	1	1	0	0	0,708554857	T82	28531,8	0,0	90750	22	100,5	0
Groupement MINDA	2	110,6	1	1	0	0	0,70990991	T11	3566,5	0,0	90750	1	101,5	0
Boutique grande	1	110	1	1	0	0	0,791237113	T11	3566,5	0,0	90750	0,5	102	0
Restaurant	3	108	1	1	0	0	0,721105528	T82	28531,8	0,0	90750	3	105	0
Grillade de Viande grande	15	108	1	1	0	0	1	T11	3566,5	0,0	90750	7,5	112,5	0
Bar - Auberge	1	100	1	1	0	0	0,761009401	T205	71329,5	0,0	90750	2,5	115	0
Pharmacie grande	1	100	1	1	0	0	0,732347328	T51	17832,4	0,0	90750	0,5	115,5	0
Pharmacie Petite	2	100	1	1	0	0	0,921641791	T11	3566,5	0,0	90750	1	116,5	0
Bar Dancing	3	100	1	1	0	0	0,840097403	T93	32098,3	0,0	90750	4,5	121	0
Atélier Électronique	1	100	1	1	0	0	0,620481928	T11	3566,5	0,0	90750	0,5	121,5	0
Cine club privé Grande	2	92	1	1	0	0	0,948009748	T62	21398,9	0,0	90750	2	123,5	0
Discothèque	1	86	1	1	0	0	0,711009174	T41	14265,9	0,0	90750	0,5	124	0
Cine club privé petit	2	86	1	1	0	0	0,948009748	T62	21398,9	0,0	90750	2	126	0
Boutique Normal	14	85	1	1	0	0	0,791237113	T11	3566,5	0,0	90750	7	133	0
Video-Club	2	80	1	1	0	0	0,775659824	T31	10699,4	0,0	90750	1	134	0
Ménage Secretaire General Prefecture	1	78	1	1	0	0	0,75	T72	24965,3	0,0	90750	1	135	0
Ménage Maire	1	72	1	1	0	0	0,793442623	T72	24965,3	0,0	90750	1	136	0
Boutique - Station de Carburant	4	65	1	1	0	0	1	T11	3566,5	0,0	90750	2	138	0
Boutique Petite	13	65	1	1	0	0	0,791237113	T11	3566,5	0,0	90750	6,5	144,5	0
Ménage Pasteur Église EFLT	1	45	1	1	0	0	0,84122807	T51	17832,4	0,0	90750	0,5	145	0
Ménage du Iman	1	36	1	1	0	0	0,82118451	T72	24965,3	0,0	90750	1	145,5	0
Ménage Inspecteur	1	36	1	1	0	0	0,84122807	T51	17832,4	0,0	90750	0,5	146	0
Ménage Paster Église Envangelique	1	36	1	1	0	0	0,84122807	T51	17832,4	0,0	90750	0,5	146,5	0
Ménage Representant Chef de Canton	1	36	1	1	0	0	0,82118451	T72	24965,3	0,0	90750	1	147,5	0
Ménage Chef Quartier	3	36	1	1	0	0	0,787644788	T31	10699,4	0,0	90750	1,5	149	0
Ménage directeur ONDR	1	36	1	1	0	0	0,84122807	T51	17832,4	0,0	90750	0,5	149,5	0
Ménage Formateur ONDR	1	36	1	1	0	0	0,84122807	T51	17832,4	0,0	90750	0,5	150	0
Ménage Directeur College	1	36	1	1	0	0	0,84122807	T51	17832,4	0,0	90750	0,5	150,5	0
Ménage Supervisor Zone EFLT	1	45	1		0	1				0,0	90750		150,5	0
École Samaritaine	1			0	0	1	0,5	T21	7133,0	0,0	90750	0	150,5	0
Adduction d'eau potable	2			0	0	1	0,522809697	T117	39231,2	0,0	90750	0	150,5	0
Antenne TLC	3			0	0	1	0,513280575	T2016	71329,5	0,0	90750	0	150,5	0
Adduction d'eau privée - pompe triphase	2	250	1	0	0	1	0,6	T2020	71329,5	0,0	90750	0	150,5	0
Centre Formation de Promotion Rurale	1	172,2	0	0	0	1	0,616839585	T44	14265,9	0,0	90750	0	150,5	0
Atelier de Soudure	3	159	0	0	0	1	0,511578306	T2012	71329,5	0,0	90750	0	150,5	0
Usine de fabrication de glace	1	129	0	0	0	1	0,502475904	T208	71329,5	0,0	90750	0	150,5	0
Imprimerie petite	4	100	0	1	0	1	0,719251337	T53	17832,4	0,0	90750	0	150,5	0
Grillade de viande petite	15	74	0	1	0	1	1	T11	3566,5	0,0	90750	0	150,5	0
Ménage Coordinateur Regional CFPR	1	72	0		0	1				0,0	90750		150,5	0
Ménage Préfect	1	72	1		0	1				0,0	90750		150,5	0
Ménage Sousprefet	1	54	1		0	1				0,0	90750		150,5	0
Ménage Agent Brigade Nomad	1	36	1		0	1				0,0	90750		150,5	0

Table 25: Final users 'list Guelendeng (TTA)

Number of users selected for Guelendeng: 30

5.2.5 Mailao

Final Users (NOMBRE DEFINITIVO)	Ut.	Social economic Priority (Punctuacion)	Willingness to Pay vs Tariff assigned (0/1)	Punctuacion tecnica (0/1)	Punctuacion Final	Budget constraint selection	FRAC.BATT.	Assigned Tariff (Txy)	Monthlee Fee	EDA (Wh/dia)
Centre de Santé	1	261	1	1	261	1	0,69	T103	35665	5500
Lycée + École - Centre B	1	194,4	1	1	194,4	1	0,91	T105	35665	5500
Ecole - Centre A	1	176,4	1	1	176,4	1	0,56	T95	32098	4950
École Catholique	1	145,8	1	1	145,8	1	0,50	T21	7133	1100
ONDR	1	142,8	1	1	142,8	1	0,57	T11	3566	550
Église de Dieu Pentecostés	1	141,6	1	1	141,6	1	0,77	T22	7133	1100
Grande Mosquée	1	141,6	1	1	141,6	1	0,67	T42	14266	2200
Église ACT	1	139,2	1	1	139,2	1	0,77	T22	7133	1100
Église AEPT Evangelique	1	135,2	1	1	135,2	1	0,77	T22	7133	1100
Garde Forestière	1	130,9	1	1	130,9	1	0,84	T11	3566	550
Gendarmerie	1	130,9	1	1	130,9	1	0,86	T11	3566	550
Tailleur grand	4	125	1	1	125	1	0,59	T21	7133	4400
Bureau Groupement des Femmes Al-Harare	1	116,2	1	1	116,2	1	0,69	T11	3566	550
Alimentation	4	115	1	1	115	1	0,71	T82	28532	17600
Chargeur de batterie téléphone	7	115	1	1	115	1	0,76	T21	7133	7700
Coiffeur	3	115	1	1	115	1	0,80	T21	7133	3300
Jardin Maraicher Individuel	3	110	1	1	110	1	0,40	T73	24965	11550
Église Catholique	1	97,6	1	1	97,6	1	0,69	T72	24965	3850
Éclairage Public	2	92	1	1	92	1	0,72	T21	7133	2200
Salle de Jeux	1	88	1	1	0	0	0,84	T93	32098	0
Bar Dancing	2	86	1	1	0	0	0,78	T31	10699	0
Video-Club	1	80	1	1	0	0	0,71	T41	14266	0
Discothèque	1	80	1	1	0	0	0,95	T62	21399	0
Cine club privé	1	30	1	1	0	0	1,00	T102	35665	0
Boutique	21	75	1	1	0	0	0,79	T11	3566	0
Ménage Présidente de l'Association de Femmes	1	45	1	1	0	0	0,99	T21	7133	0
Ménage du Chef du Village	1	45	1	1	0	0	0,79	T83	28532	0
Ménage du Directeur de l'École A	1	45	1	1	0	0	0,84	T51	17832	0
Ménage du Iman	1	45	1	1	0	0	0,99	T21	7133	0
Ménage Pasteur de Dieu	1	45	1	1	0	0	0,84	T51	17832	0
Ménage Pasteur AEPT	1	45	1	1	0	0	0,84	T51	17832	0
Ménage Apotre AEPT	1	45	1	1	0	0	0,84	T51	17832	0
Ménage Pasteur ACT	1	45	1	1	0	0	0,84	T51	17832	0
Ménage Chef Garde Forestier	1	36	1	1	0	0	0,79	T31	10699	0
Ménage Collecteur du Marché	1	36	1	1	0	0	0,99	T21	7133	0
Ménage Président de l'Association de Jeunes	1	36	1	1	0	0	0,99	T21	7133	0
Ménage blama	10	36	1	1	0	0	0,79	T51	17832	0
Ménage Prete Église Catholique	1	36	1	1	0	0	0,84	T51	17832	0
Ménage President Commision de charge	1	36	1	1	0	0	0,99	T21	7133	0
Petite Mosquée	2	141,6	1	0	0	1	0,65	T31	10699	0
CEC Caisse d'Épargne et de Crédit	1	141,4	0		0	1				0
Grillade de viande	4	96	0	1	0	1	1,00	T11	3566	0
Tailleur petit	3	92,5	0	1	0	1	0,59	T21	7133	0
Pharmacie	1	75	0	1	0	0	0,92	T11	3566	0
Boutique - Station de Carburant	3	75	0	1	0	0	1,00	T11	3566	0
Ménage Directeur ONDR	1	45	1	1	0	0	0,99	T21	7133	0
Ménage Leader Boukar	1	36	1	1	0	0				0
Ménage à faible revenu	18	14	1	0	0	0	0,99	T21	7133	0
Atelier de Soudure	1	0	0	0	0	0	0,51	T2012	71330	0
Moulin	11	0	0	0	0	0	0,50	T113	39231	0
Antenne TLC	1	0	0	0	0	0	0,51	T2016	71330	0
Centre d'Animation Rurale	1	0	0	0	0	0	0,74	T207	71330	0
Magasin	56	0	0	1	0	0	1,00	T11	3566	0

Table 26: Final users 'list Mailao (TTA)

Number of users selected for Mailao: 36

7. PROPOSED TECHNICAL SOLUTIONS

Before the description of each single installation in Douguia (chapter 5.1), Mombou (chapter 5.2), Dourbali (chapter 5.3), Guelendeng (chapter 5.4), and Mailao (chapter 5.5), special focus is made on:

- the main parameters used for the design
- the two main functional configuration of PV power plant
- the modularity of the PV power plant
- the main parameter of the distribution line

Main design parameters

The PV power plants designed for the five communities of Douguia, Mombou, Dourbali, Guelendeng and Mailao are autonomous PV power plants with a PV generator in the range of 30-50 kWp.

For the design it has been considered the following hypothesis:

- Simultaneity factor in the demand consumption: 85%
- Simultaneity factor in power distribution: 30%
- Irradiation
- Consumption growth: 30% of the 2013 energy consumption
- Performance ratio: 60%
- Battery autonomy: 3 days altogether with night factor energy demand
- Service quality: 230V / 50Hz

Technical requirement – Functional configuration

Technically, there are two design topologies:

- one for Mombou village called PV power plant with distributed inverter
- one for the other four villages (Douguia, Dourbali, Guelendeng and Mailao) called centralized PV power plant

Centralized PV power plant

The main characteristic of the centralized PV power plant is that there is a single distribution line to the AC loads

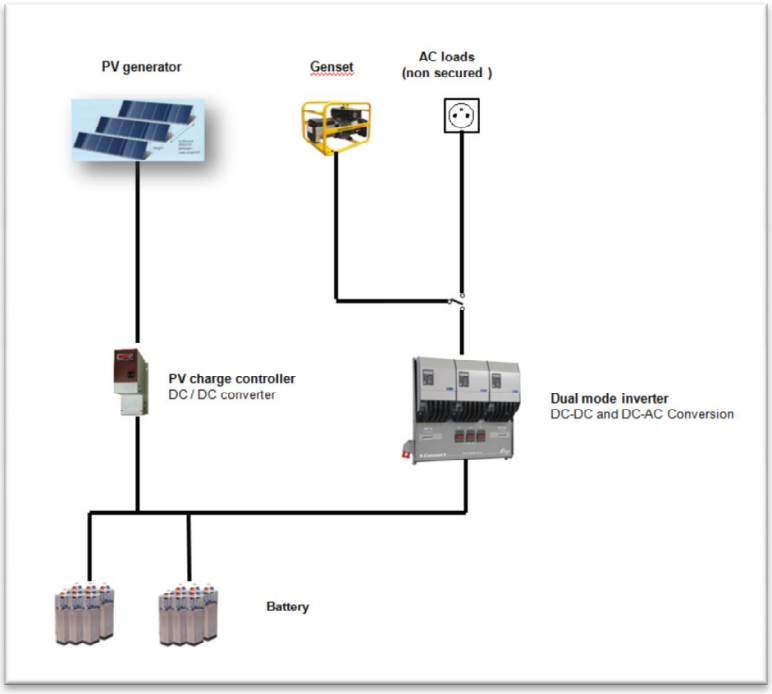


Figure 12: Arquitecture solution 1 (TTA)

The PV power plant is based on a central 3 phase inverter which provides voltage and frequency for the island grid.

In this centralized PV power plant, if more than one battery bank is needed, they are directly connected in parallel. In any case, the number of battery bank to be connected in parallel would not exceed two battery banks to reduce premature ageing and electrical trouble such as shorted cell.

For the four village that will have a centralized PV power plant:

- Douguia and Dourbali will have two battery banks
- Guelendeng and Mailao will have a single battery bank

The functional description of the facility can be summarized as follows:

- Micro grid with normal supply
- The PV power plant is in overconsumption
- The PV power plant is overloaded
- The PV power plant has an excess of energy
- Battery charging from the genset

The modes of operation are automatically triggered by the load management and plant supervision strategy and the state of charge of the battery, PV generation and conditions of the day: switch off certain loads, charging exclusively from PV or not, etc.

PV power plant with distributed inverter

The main characteristic of the centralized PV power plant is that there are two distribution lines to the AC loads. For Mombou village the two distribution lines dispense the two districts: Mombou Grand and Mombou Petit.

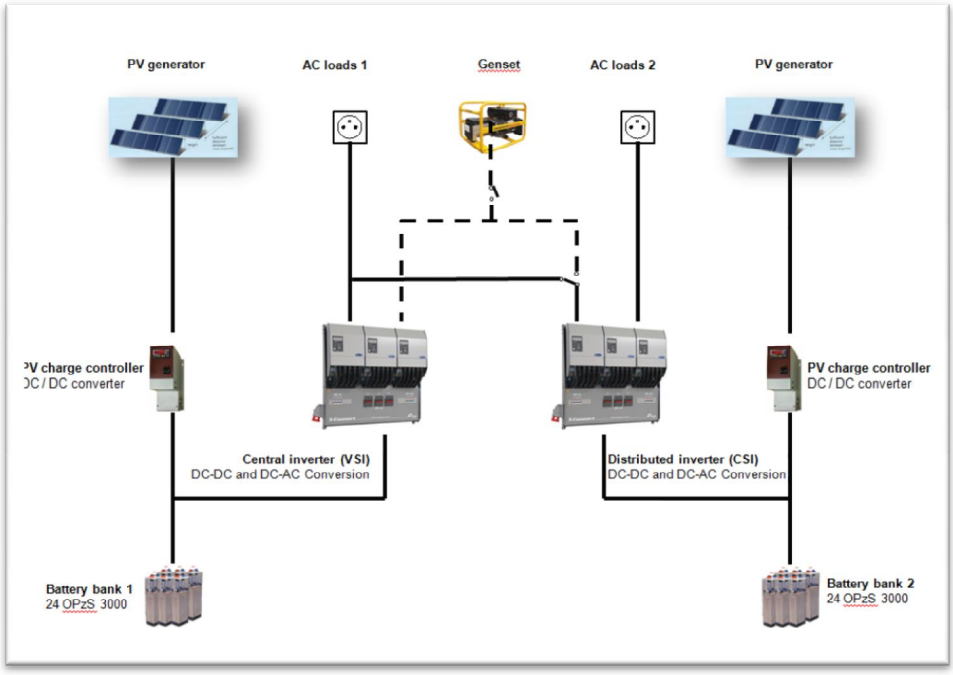


Figure 13: Arquitecture solution 2 (TTA)

The PV power plant is based on:

- 1 central 3 phase inverter which provides voltage and frequency for the island grid
- 1 distributed 3 phase inverter acting as a current source

In this distributed inverter topology with shared energy, two 4.500 Ah battery bank are connected in parallel, but not directly: the inverter will try to balance the two battery voltages but this paralleling is done through the inverter and each bank is managed separately.

The functional description of the facility can be summarized as follows:

- Micro grid with normal supply
- The central system has more energy that the distributed
- The distributed system has more energy than the central
- The central system is in overconsumption
- The distributed system is in overconsumption
- The central system is overloaded
- The distributed system is overloaded
- Excess energy of the central system
- Excess energy of the distributed system
- Battery charging from the genset

The modes of operation are automatically triggered by the load management and plant supervision strategy and the state of charge of the battery, PV generation and conditions of the day: switch off certain loads, charging exclusively from PV or not, etc.

Modularity

PV power plants designed for this study are modular and a future extension can be realized considering the following case:

- Introduce new decentralized renewable energy sources (like PV or wind turbine) in the PV power plant, for the electrification of a new district for example. Any PV module or wind turbine with a battery charge controller can be used and interfaced to the micro grid with a Studer inverter-charger used as current source (CSI). In that case, a new distribution line must be installed because the proposed distribution line is not sized to accept more power
- A business / administrative institution requiring more energy consumption: it can pay for its own solar PV modules for the extra energy needed and take on the PV power plant (common property) an allowed energy quota

Further, in case if increase of the PV power plant, different inverter models, size, even different battery voltages can be used.

Distribution line

Below, a table which present the main characteristics of the distribution line:

	Douguia	Mombou	Dourbali	Guelendeng	Mailao
Number of distribution line	1	2	1	1	1
Distribution line	3 Φ	3 Φ	3 Φ	3 Φ	3 Φ
Power distribution	LV	LV	LV	LV	LV
Earthing	TNCS/TT	TNCS/TT	TNCS/TT	TNCS/TT	TNCS/TT
Loads	1 Φ	1 Φ	1 Φ	1 Φ	1 Φ

Table 27: Distribution lines characteristics (TTA)

In any case, the distribution line has been designed for the 2013 energy consumption need of each community. No increasing factor for the power distribution had been taken into account. If new solar generation is installed, it must be installed a new distribution line for new users.

Other aspects

PV power plants had been designed considering a 30% consumption growth for the user connected to the PV power plant. In any case this consumption growth should be used to connect new users.

If new users express their interest to be connected to the PV power plant, an enlargement of the PV power plant must be done with a new:

- PV generator
- Battery bank
- inverter
- distribution line

Such an enlargement is illustrated in the figure below: in red the new equipments that need to be installed.

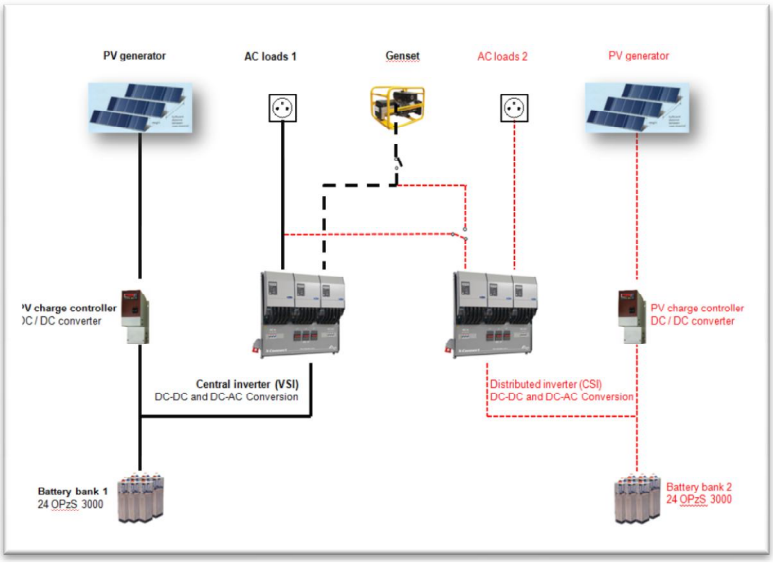


Figure 14: Modularity of the arquitecture for future installation (TTA)

To be noted that this enlargement is not a new independent power plant. Indeed, as explained above the modularity of the PV power plant is able to be enlarged.

In case of enlargement, special attention must be done to the location of the new PV generator. In some villages, it is possible to centralize the solar generation because some room is left next to the initial PV generator. In other villages, a distributed generation must be planned. Anyway the enlargement of the PV power plant is possible in both cases.

Monitoring of each PV power plant must be done remotely using the 2G national communication network.

5.1 PHASE 1

In the following paragraph a schematic resume of the technical characteristics proposed for each village are presented.

5.1.1 Douguia

PV generator	
Daily load demand	121.923 Wh/dia
Sun Peak Hour "worst case"	Junio
Demand growth factor	30%
Sun Peak Hour "worst case"	6,20 HPS
Performance Ratio	60%
Daily load demand for design	158.500 Wh/dia
PV generator	42.780 Wp

PV generator configuration	
PV module	230 W Poly
Serie of PV module	2
Number of PV module	186
Area of PV array	324 m2
Weight	3.960 Kg

PV charge controller	
PV charge controller	Circutor UD80
Number of PV charge controller	10

Battery	
Autonomy (days)	3
Night load demand factor	57%
Battery voltage	48 V
Battery Depth Of Discharge	70%
Battery capacity	8.006 Ah
Battery type	24 OPzS 3000
Number of 2V element to install	24
Weight	5.760 Kg

Inverter	
Power demand	13,23 kW
Inverter type	Studer XTH 8000-48
Continuous Power [W]	7.000 W
Power 30 min. [W]	8.000 W
Number of inverter	3

Distribution line	
Number of housing	55,5
Number of electric dispenser	54
Ditribution type	3 phase
Number of distribution line	1
Number of poles	62
Housing installation	No

Public street lighting	
Number of lamps	22
Lamps power (high pressure sodium)	70 W
Crepuscular sensor	1

Monitoring system	
Battery Supervisory controller	1
SCADA software	1
GPRS/GSM Modem	1

Genset	
Number of genset	1
Rated power	35 kW
Genset type	3 phase

Table 28: Technical characteristics for Douguia (TTA)

5.1.2 Mombou

PV generator	
Daily load demand	118.179 Wh/dia
Sun Peak Hour "worst case"	Junio
Demand growth factor	30%
Sun Peak Hour "worst case"	6,20 HPS
Performance Ratio	60%
Daily load demand for design	153.633 Wh/dia
PV generator	41.400 Wp

PV generator configuration	
PV module	230 Poly
Serie of PV module	2
Number of PV module	180
Area of PV array	295 m2
Weight	3.600 Kg

PV charge controller	
PV charge controller	Circutor UD80
Number of PV charge controller	10

Battery	
Autonomy (days)	3
Night load demand factor	67%
Battery voltage	48 V
Battery Depth Of Discharge	70%
Battery capacity	9.200 Ah
Battery type	24 OPzS 3000
Number of 2V element to install	24
Weight	5.760 Kg

Inverter	
Power demand	17,36 kW
Inverter type	Studer XTH 6000-48
Continuous Power [W]	5.000 W
Power 30 min. [W]	6.000 W
Number of inverter	6

Distribution line	
Number of housing	139
Number of electric dispenser	138
Ditribution type	3 phase
Number of distribution line	2
Number of poles	150
Housing installation	No

Public street lighting	
Number of lamps	22
Lamps power (high pressure sodium)	70 W
Crepuscular sensor	1

Monitoring system	
Battery Supervisory controller	1
SCADA software	1
GPRS/GSM Modem	1

Genset	
Number of genset	1
Rated power	35 kW
Genset type	3 phase

Table 29: Technical characteristics for Mombou (TTA)

5.2 PHASE 2

5.2.1 Dourbali

PV generator	
Daily load demand	55.714 Wh/dia
Sun Peak Hour "worst case"	Junio
Demand growth factor	30%
Sun Peak Hour "worst case"	6,20 HPS
Performance Ratio	60%
Daily load demand for design	72.428 Wh/dia
PV generator	19.780 Wp

PV generator configuration	
PV module	230 Poly
Serie of PV module	2
Number of PV module	86
Area of PV array	147 m2
Weight	1.800 Kg

PV charge controller	
PV charge controller	Circutor UD80
Number of PV charge controller	5

Battery	
Autonomy (days)	3
Night load demand factor	55%
Battery voltage	48 V
Battery Depth Of Discharge	70%
Battery capacity	3.542 Ah
Battery type	24 OPzS 3000
Number of 2V element to install	24
Weight	5.760 Kg

Inverter	
Power demand	7,02 kW
Inverter type	Studer XTH 5000-24
Continuous Power [W]	4.500 W
Power 30 min. [W]	5.000 W
Number of inverter	3

Distribution line	
Number of housing	42
Number of electric dispenser	42
Ditribution type	3 phase
Number of distribution line	1
Number of poles	80
Housing installation	Yes

Public street lighting	
Number of lamps	0
Lamps power (high pressure sodium)	0
Crepuscular sensor	0

Monitoring system	
Battery Supervisory controller	1
SCADA software	1
GPRS/GSM Modem	1

Genset	
Number of genset	1
Rated power	35 kW
Genset type	3 phase

Table 30: Technical characteristics for Dourbali (TTA)

5.2.2 Guelendeng

PV generator	
Daily load demand	83.285 Wh/dia
Sun Peak Hour "worst case"	Junio
Demand growth factor	30%
Sun Peak Hour "worst case"	6,20 HPS
Performance Ratio	60%
Daily load demand for design	108.270 Wh/dia
PV generator	29.440 Wp

PV generator configuration	
PV module	230 Poly
Serie of PV module	2
Number of PV module	128
Area of PV array	210 m2
Weight	2.560 Kg

PV charge controller	
PV charge controller	Circutor UD80
Number of PV charge controller	8

Battery	
Autonomy (days)	3
Night load demand factor	32%
Battery voltage	48 V
Battery Depth Of Discharge	70%
Battery capacity	3.139 Ah
Battery type	24 OPzS 3000
Number of 2V element to install	24
Weight	5.760 Kg

Inverter	
Power demand	13,24 kW
Inverter type	Studer XTH 6000-48
Continuous Power [W]	5.000 W
Power 30 min. [W]	6.000 W
Number of inverter	3

Distribution line	
Number of housing	27
Number of electric dispenser	27
Ditribution type	3 phase
Number of distribution line	1
Number of poles	152
Housing installation	No

Public street lighting	
Number of lamps	36
Lamps power (high pressure sodium)	70
Crepuscular sensor	1

Monitoring system	
Battery Supervisory controller	1
SCADA software	1
GPRS/GSM Modem	1

Genset	
Number of genset	1
Rated power	35 kW
Genset type	3 phase

Table 31: Technical characteristics for Guelendeng (TTA)

5.2.3 Mailao

PV generator	
Daily load demand	70.806 Wh/dia
Sun Peak Hour "worst case"	Junio
Demand growth factor	30%
Sun Peak Hour "worst case"	6,20 HPS
Performance Ratio	60%
Daily load demand for design	92.048 Wh/dia
PV generator	24.840 Wp

PV generator configuration	
PV module	230 Poly
Serie of PV module	2
Number of PV module	108
Area of PV array	177 m2
Weight	2.160 Kg

PV charge controller	
PV charge controller	Circutor UD80
Number of PV charge controller	6

Battery	
Autonomy (days)	3
Night load demand factor	38%
Battery voltage	48 V
Battery Depth Of Discharge	70%
Battery capacity	3.151 Ah
Battery type	24 OPzS 3000
Number of 2V element to install	24
Weight	5.760 Kg

Inverter	
Power demand	11,23 kW
Inverter type	Studer XTH 6000-48
Continuous Power [W]	5.000 W
Power 30 min. [W]	6.000 W
Number of inverter	3

Distribution line	
Number of housing	35
Number of electric dispenser	35
Ditribution type	3 phase
Number of distribution line	1
Number of poles	62
Housing installation	No

Public street lighting	
Number of lamps	26
Lamps power (high pressure sodium)	70
Crepuscular sensor	1

Monitoring system	
Battery Supervisory controller	1
SCADA software	1
GPRS/GSM Modem	1

Genset	
Number of genset	1
Rated power	35 kW
Genset type	3 phase

Table 32: Technical characteristics for Mailao (TTA)

8. ECONOMIC SUSTAINABILITY OF THE ELECTRICITY SERVICE

This chapter deals with the results of the economic study performed with the scope of defining a proper tariff fees scheme which can guarantee the coverage of the O&M costs of the electricity service and the reposition of material.

As anticipated the study has been conducted in accordance to the fact that the budget has been divided into two steps.

In the tables below it has been illustrated the respective numbers for the two phases of the installation.

PHASE I (Douguia y Mombou)

DIESEL COSTS	Unit	USD / Unit
Generation hours per day	h/Day	4,000
Lubrificant consume	litres/kWh	0,002
Fuel Diesel consume	litres/kWh	0,450
Lubrificant cost	USD/litre	3,946
Diesel fuel cost	USD/litre	1,014

Table 33 Diesel unit costs for the backup generator (Source: TTA)

FIX O&M COSTS	Nº	Dedication (% / year)	Gross Salary (EUR/month)	TOTAL (EUR/year)	TOTAL (USD/year)
Administrative Manager	1	0,3	198	1425	1926
Financial Contractor	1	0,3	198	1425	1926
Guardian	1	1	91	2184	2951
Technical specialist	1	0,5	152	1824	2465
Enterprise Technical O&M	1	1	250	6000	8108

Table 34 O&M Service costs for Douguia and Mombou (Source: TTA)

As per the reposition costs it has been considered that the batteries and the gen-set will be the main costs to be covered in the first 10 years as the battery estimated life is about 7 years and the gen-set (backup usage only) will be about 6 years.

With this hypothesis the costs at the year 7 for the batteries of the two villages will be about

128.000 USD while the costs of reposition for the diesel genset will be about 29.000 USD.

Item	Year of reposition	Reposition Cost
Gen-set	6	29.000 USD
Batteries	7	128.000 USD

Table 35: Main reposition costs for PHASE I (TTA)

In order to cover these costs the tariff scheme has to be studied and the fees calculated.

Generally speaking the tariff scheme preferable for the RE systems is a fix monthly fee which will guarantee the energy level demanded by each users. The recommended tariff fees calculated are reported in the table below.

TARIFF PROFILE	EDA (kWh/day)	POWER (W)	TOTAL w/o PL (USD/month)
T11	550	0,5	6,69
T21	1100	0,5	13,38
T31	1650	0,5	20,07
T41	2200	0,5	26,76
T42	2200	1	26,76
T51	2750	0,5	33,45
T53	2750	1,5	33,45
T54	2750	2	33,45
T62	3300	1	40,14
T63	3300	1,5	40,14
T72	3850	1	46,82
T73	3850	1,5	46,82
T82	4400	1	53,51
T820	4400	10	53,51
T93	4950	1,5	60,20
T92	4950	1	60,20
T102	5500	1	66,89
T105	5500	2,5	66,89

Table 36: Tariff scheme and fee hypothesis (TTA)

With this tariff the final economic figure will be as the one illustrated below:

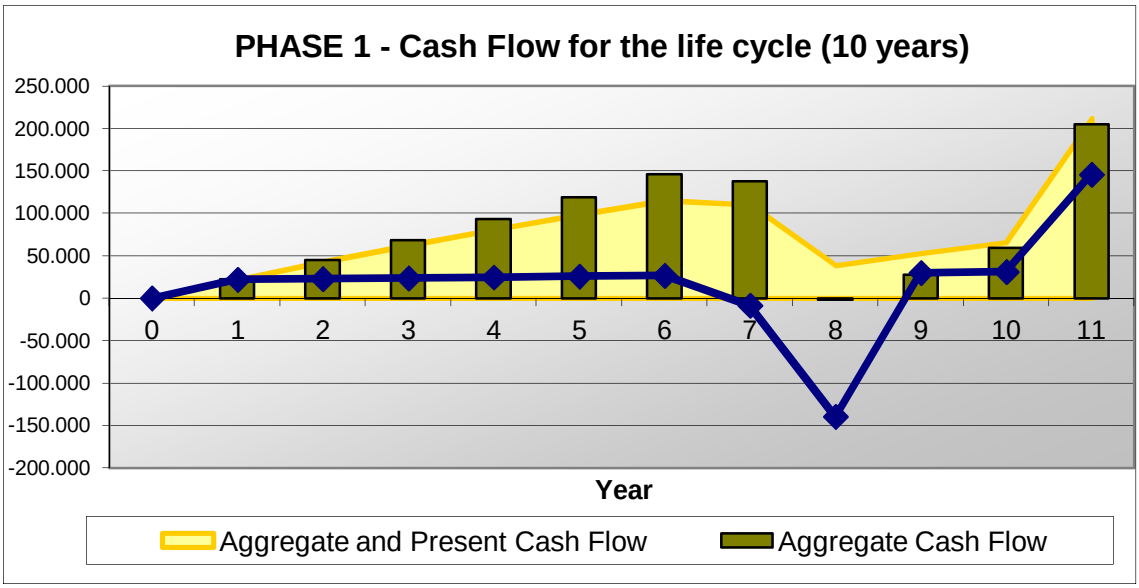


Figure 16: Cash flow for the Phase I installation (source: TTA)

As it can be seen the figure is always positive and the final Net Present Value (NPV) is about:

NPV = 122,345 USD

PHASE II (Dourbali, Guelendeng, Mailao)

The costs for this phase are the same in terms of diesel unit costs while the O&M costs will vary accordingly to the fact that we have 3 villages now instead of 2. The table below indicate the new figure.

FIX O&M COSTS	Nº	Dedication (% / year)	Gross Salary (EUR/month)	TOTAL (EUR/year)	TOTAL (USD/year)
Administrative Manager	1	0,3	198	2138	2890
Financial Contractor	1	0,3	198	2138	2890
Guardian	1	1	91	3276	4427
Technical specialist	1	0,5	152	2736	3697
Enterprise Technical O&M	1	1	250	9000	12162

Table 37 O&M Service costs for Dourbali, Guelendeng and Mailao (Source: TTA)

Considering the same economic parameters hypothesis, the tariff fees figure proposed is the following:

TARIFF PROFILE	EDA (kWh/day)	POWER (W)	TOTAL w/o PL (USD/month)
T11	550	0,5	7,36
T21	1100	0,5	14,72
T22	1100	1	14,72
T31	1650	0,5	22,07
T32	1650	1	22,07
T33	1650	1,5	22,07
T41	2200	0,5	29,43
T42	2200	1	29,43
T44	2200	2	29,43
T51	2750	0,5	36,79
T52	2750	1	36,79
T53	2750	1,5	36,79
T55	2750	2,5	36,79
T62	3300	1	44,15
T72	3850	1	51,51
T73	3850	1,5	51,51
T74	3850	2	51,51
T76	3850	3	51,51
T82	4400	1	58,86
T93	4950	1,5	66,22
T95	4950	2,5	66,22
T102	5500	1	73,58
T103	5500	1,5	73,58
T105	5500	2,5	73,58
T113	6050	1,5	80,94
T114	6050	2	80,94
T126	6600	3	88,30
T143	7700	1,5	103,01
T152	8250	1	110,37
T173	9350	1,5	125,09

Table 38: Tariff scheme and fee hypothesis (TTA)

With this tariff the final economic figure will be as the one illustrated below:

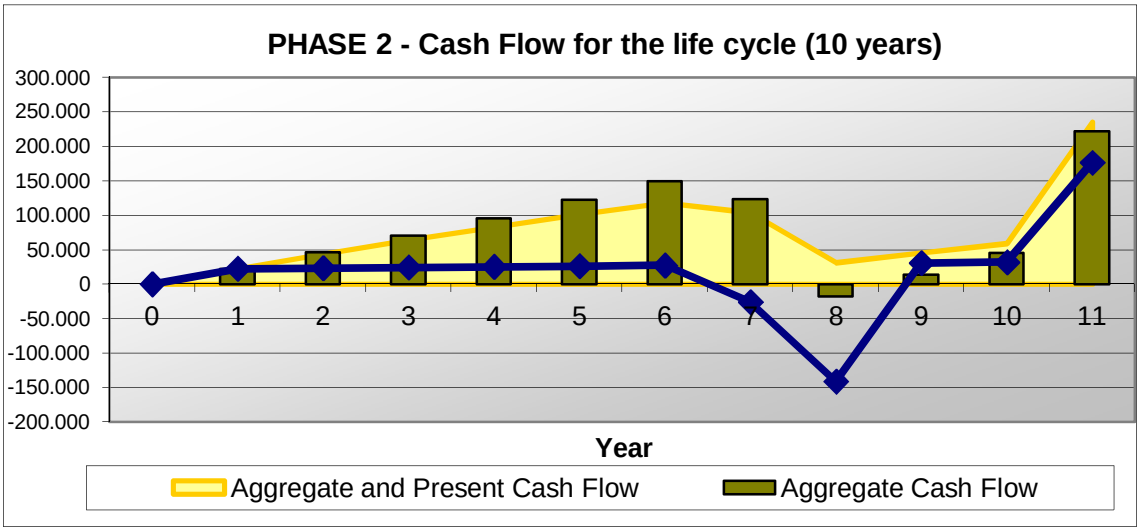


Figure 17: Cash flow for the Phase I installation (source: TTA)

As it can be seen the figure is always positive except the year 8 where the operator will have to sustain the battery replacement with a small amount BUT the entire figure is sustainable with a final Net Present Value (NPV) of about:

NPV = 127,234 USD

9. PROPOSED SERVICE MANAGEMENT MODEL

Chad has not experienced any rural electrification project at the moment. So there are no previous experiences for electricity service management models in these contexts.

Nevertheless, as exposed in the previous chapter, the 5 villages visited during the Inception Mission phase are, generally speaking, characterized by a high level of community-based organizational structure and operability for what it concerns the community service (e.g. water supply, fishing etc.). In most of the villages the services management model analysed is based on community associations for what it is related to the Operation and Maintenance of the infrastructure, financial management, organizational structure. For particular complicated technical aspects, the external support of private company has been accepted and, with the arriving of international agency founded project, actually recommended. In this sense the presence of the support for technical issues as well as for the financial management of the resources has generated a high level of satisfactory success for the same communities involved.

For this reason, it has been analysed in detailed the water supply service in Douguia. This is a public service settled with the help of the EU funds.

While the State is the owner and partially responsible of the infrastructure, the local association, specifically created for this purpose, is in charge for the basic activities of the O&M, for the collect of the fees and financial management and for the security of the installation. Furthermore the community has foreseen an auto-controlling mechanism in order to prevent possible failures in the processes.

As per the technical issues as well as for the financial frequently status-check, a private company has been contracted by a public tender.

This has provided to great results, not only for the functionality of the service but also for the financial status of the association itself. These aspects have been detected during the contractor mission.

Furthermore, culturally speaking, Chadian community are well organized and they look favourably to the community association based management model.

For this reasons in this report, the proposed management model has been thought, discussed and designed between the parties, according to the mentioned structure.

Institutional Component	Responsibility	Actor
Project coordinator	Defining key responsibility accordingly to the legal and administrative framework.	Ministry of Oil And Energy
Social community developer	Community involvement, wiring mechanism, association creation process	TTA with local support
Technical director	- Supervision of Basic activity of O&M - Preventive and corrective O&M - Follow-up of the performances	External Private Company
System Installer	Technical installation and works	Solaire Tchad
Capacitor	Capacity building	TTA
Maintenance	Preventive and corrective maintenance	Contracted company
Owner of the systems		State
Service Operator	Collect of the fees, administrative and organizative activities, service management, basic maintenance, security	Local Association
Regulator	Define tariff fee, operators rules etc, in the respect of the legal framework.	Local Association
Monitoring and evaluation responsible	Supervise that the correct operational activities are followed and check on the system performances	Contracted company

Table 39: Key roles and responsibilities proposal for the project (TTA)

As it can be seen it has been assumed that the State is the owner of the systems but the local association will be the Electricity Service Operator so in charge technical, administrative, financial aspects. For this reason it is recommended that for the more critical

aspects it will be helped by private company selected with a public tender, will be in charge for the good performance of the system (technically) and of the service (financially). For this last aspect it worth to mention that the model proposed here foresee that, as it happens in other service context, the tariff fees are selected by the Association itself (regulatory responsibility) in order to guarantee the financial sustainability of the service. The contractor, during this inception mission phase has calculated a tariff fee reference accordingly to the community systems illustrated above.

For the structure proposal it worth to go in details. This structure has been discussed and shaped according to the water service structure in Douguia, and it the proposed structure by the contractor is showed below.

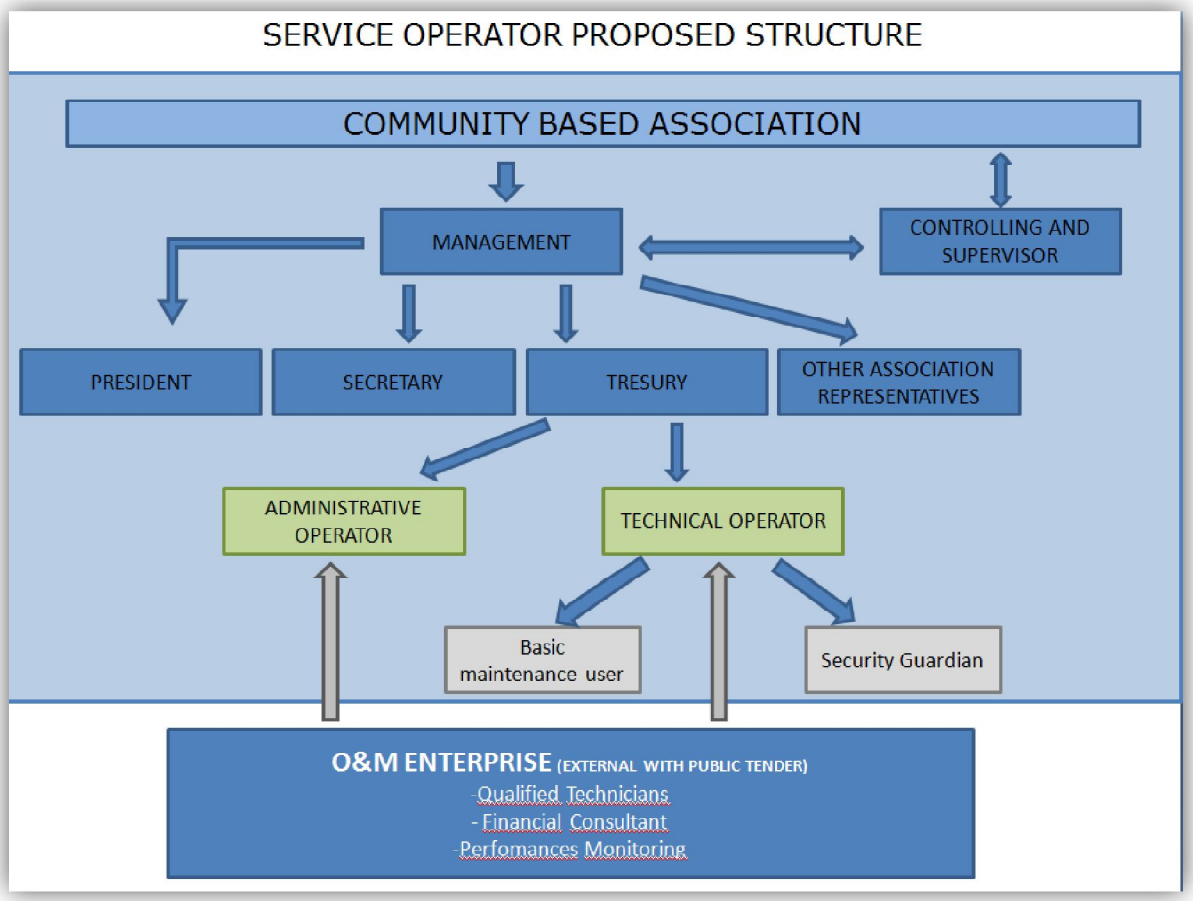


Figure 18: Proposed Service Management Model (Source: TTA)

According to this structure the Community Association, after a specific capacity building on the key roles and responsibility, will choose the adequate persons within the community. The top management is an organ where important community representatives sit and include:

- President
- Secretary
- Other association representatives
- Treasury

This last component of the management is the one which is directly involved in the O&M of the micro-grid and in particular it will deal with the financial, administrative and technical aspects of the system operation.

In particular it will have to cover the following key roles:

Administrative operator:

This role is in charge for the collection of the monthly tariff fee, administrative aspects (e.g. tariff update and recharge in the Dispenser Meter.

The person in charge for this role will ideally have a bachelor + 2 study level and will report directly to the treasury of the association.

Technical operator:

These persons will have to be chosen also in the within the community and should include at least the following figures:

- **Basic maintenance user:** capacity built users who will be responsible for the activities of the basic maintenance (e.g. battery liquid level check, PV modules cleaning, etc.), as well as to scale up more complicated technical occurrence to the O&M enterprise.
- **Security guardian:** this person will have to avoid damage and vandalism occurrence and will be living in the structure specifically built within the PV generator perimeter.

O&M Enterprise:

An external O&M enterprise is recommended to be contracted in order to support the high level activities of O&M. This should include the following figures:

- **Qualified technicians:** this professionals technicians will be involved in the periodic preventive and corrective O&M activities, spare parts substitutions etc...
- **Financial contractor:** this role is critical as it will be involved and responsible of the sustainable management of the financial resources of the association. Is critical as the correct management of the financial aspects will allow sustaining economically the service through the life cycle period, under technical and administrative point of view.

IMPORTANT: it is important to put in evidence here the fact that the management model has to be economically sustaining with the tariff fees collection revenues. In particular this aspect, together with the spare parts substitution, is the costs item which will have to be covered by the tariff fees. These fees, therefore, has been calculated taking into account the direct cost of the management model which involved the following roles:

- Administrative operator
- Technical operator
- O&M Enterprise

Plan for the association constitution

Before the materials arrive to Chad and the first piece has been installed the Association must be already be created and capacity building performed.

In this sense it is recommended to face this phase of the project during the materials transportation period (estimated in 2/3 months).

The contractor is capable, with the support of its local partner, to follow this phase which will consist of:

- Preparation of the key role description and identification criteria documents
- General Assembly with the community (one meeting each community)
- Key actors identification by the community general assembly
- Capacity Building of the Actors (one session for all the association together).

10. OTHER RECOMMENDED ADDITIONAL SERVICES

As agreed with the client, there are some additional services which were not included in the initial tender but which are critical for the project and for the service sustainability.

On top of the operator legal creation, already described in the previous chapter, the agreed services are:

- Inception mission report
- Kick-off meeting in N´Djamena

The additional service recommended by the client after the facts finding during the inception mission are the following:

- 1 year accompanying period

In addition to these services the wiring mechanism concepts and costs should be agreed with the client.

These three chapters will be included in the project costing table in order to be discussed and approved.

In the following chapter the more relevant of these services are described.

SUPPORT FOR LARGE USERS PRIVATE INVESTMENTS MECHANISM

During the activity of the management model creation, the contractor will be present in the field for a 5 month period approximately. This period has been also calculated to give the resident engineer the time enough for contacting with the large private users which, for technical reason of incompatibility with the technology solution adopted in this project, has been excluded from the electricity service.

The reason for this exclusion is related to the fact that the methodology followed foresee to provide the access to a grid-quality electricity service to the higher number of target users.

In this sense, too large users would have requested such a PV capacity to cover their energy need that most of the small (but social-economically important) users would have been excluded.

Furthermore the contractor recommend to support those large users with an agreed solution which try to involve private investments for photovoltaic installation which definitely can be positive as well for the community development and to create pilot experience for other private entity.

8.1 1 YEAR ACCOMPAINING PERIOD

After the commissioning of the system it is recommended that a period of supervision of the system itself and its performances are performed by the local installer with a remote support from the contractor.

During the inception mission it has been identified that this period is particular important in Chad for the climate conditions, for the security context, for O&M training process follow up and, generally speaking for the system operation parameter fine tuning.

8.2 WIRING MECHANISM

The contractor has identified a possible scenario in order to achieve that the users could be pushed to install his own electrical internal connections including sockets and light points.

The proposal consists in offering the users a basic installation within the project. This installation will have to be performed by local users. Capacity building and support to the installation will be provided by the contractors.

With basic installation the contractor refers to 2 light points, 2 sockets, cables and accessory materials as reported in the table below.

In the table below there is a reference costs of the material considered.

DOMESTIC INSTALLATION					
ID		**Unit**	**Item**	**Qt.**	**USD**
			Supply of 6 + 6 points of light power bars including wiring, for indoor installation in housing.		
	1	ut	Supply socket surface	2	6,10
	2	ut	Supply surface fastener switch	2	4,12
	3	ut	CFL Supply 15W/E27	2	7,07
	4	ut	E27 supply wall mounting	2	2,74
	5	ml	Hose 3x1, 5mm2 RV1KV	20	0,82
	6	ml	Hose 3x2, 5mm2 RV1KV	20	1,22
	7	ut	Surface junction box 100x100	2	2,28
	8	PA	Small cultch derivation	2	9,13
		TOTAL INTERIOR INSTALLATION MATERIAL			103,78

Table 40: Proposed installation material costs (TTA)

The estimated number of basic package installation is reported in the table below:

TARIFF	USER TIPOLOGY	EDA (kWh/day)	POWER (W)	N° USERS MOMBOU	N° USERS DOUGUIA	Ut BASIC INSTALLATION (2 lights and 2 sockets)	TOTAL BASIC INSTALLATION MOMBOU	TOTAL BASIC INSTALLATION DOUGUIA
T11	Menages, Groupèment Tontines, Atelier electronique, Boutiques	550	0,5	112	8	2	224	16
T21	Chargeur de batterie téléphone, Petite Mosque, Tailleure, Coiffeur	1100	0,5	6	13	3	18	39
T31	Gendarmerie	1650	0,5	0	1	4	0	4
T41	Ecole Petite, Menage Representants petite	2200	0,5	5	1	4	20	4
T42	Bureau Petite, Mosque	2200	1	1	1	6	6	6
T51	Ecole, Menage media	2750	0,5	2	9	6	12	54

T53	ONDR	2750	1,5	0	1	9	0	9
T54	Bureau ADVIM	2750	2	1	0	6	6	0
T62	Menage directeur ADVIM, cineclub privée	3300	1	1	3	4	4	12
T63	Garage	3300	1,5	1	0	2	2	0
T72	Menage representants grande	3850	1	1	4	5	5	20
T73	Pompage Jardin, Grande Mosque, groupement grande	3850	1,5	5	3	6	30	18
T82	Alimentation	4400	1	2	5	3	6	15
T820	Adduction d'eau potable	4400	10	0	1	3	0	3
T92	Centre de Santée	4950	1	1	1	7	7	7
T93	Groupement KYEE	4950	1,5	0	1	3	0	3
T102	Eclairage publique	5500	1	1	1	-	0	0
T105	Ecloe grande-college	5500	2,5	0	2	13	0	26
						TOTAL BASIC INSTALLATION	340	236

Table 41: Estimated number of basic package for internal installation (TTA)

Then the total estimated budget for this mechanism is about

(340 + 236)* 103,78 = 59,777 USD

11. WORK PLAN

In this section it is illustrated the estimation of the time and organizational plan for the second phase of the project. This plan will be divided into the following main steps:

- Preliminary works
- Civil engineering
- Installation (PV part)
- Installation of auxiliary genset
- Management model legal constitution
- Installation of the electric distribution
- Installation of the internal housing system
- Testing and commissioning
- Training activities
- Reception of the installation

As per the time plan, in the table below it can be seen the contractor´s proposal for PHASE I and PHASE II.

PHASE I

Tasks			week
0. Preliminary works			
0.1		Contract signature-UNIDO-TTA	1
0.2		Detailed engineering	3
0.3		Preparation and approval of the facility management model	3
0.4		Launching of material release order	1
0.5		Collection and storage of materials	4
0.6		Contracting with local industrial	2
0.7		Verification and packaging of the material	1
0.8		Pre-assembly of electrical panels and protections	2
0.9		International transport of the equipment	8
0.10		Customs clearance	1
1. Civil engineering (1st phase)			
1.1		Redesign of civil foundations	1
1.2		Redesing of distribution line poles	1
1.3		Planning and organization of the work teams	1
1.4		Check of civil engineering material	1
1.5		Constructions	6
1.6		Mounting support structure of PV panels	4
1.7		Finalize equipment rooms	2
1.8		Check of civil engineering and structures	1
1.9		Reception of civil engineering and structures	1
2. Installation of photovoltaic (1st phase)			
2.1	**Local transport of equipments de equipos**		
	2.1.1	Local transport of equipment to the site	1
	2.1.2	Local storage of equipment	1
2.2	**Redesign**		
	2.2.1	Redesign of equipment installation	1
2.3	**PV modules**		
	2.3.1	PV module mounting on structure	2
	2.3.2	Wiring PV module series	1
	2.3.3	Wiring PV generator and boxes junction	1
2.4	**Batteries**		
	2.4.1	Installation of batteries	0,4
	2.4.2	Installation of electrical box with general fuse	0,2
	2.4.3	Wiring batteries	0,4
2.5	**Photovoltaic equipments**		
	2.5.1	Installation of PV charge controllers	0,2
	2.5.2	Installation of PV inverters	0,2
	2.5.3	Installation of electrical box with AC and DC protections	0,2
	2.5.4	DC side wiring	0,4
	2.5.5	AC side wiring	0,6
	2.5.6	Installation of electrical box with AC outlet protections	0,4
2.6	**Monitoring system**		
	2.6.1	Wiring of sensors and data logger	0,2
	2.6.2	Wiring of communication line (ethernet or GSM)	0,2
	2.6.3	Installation of monitoring software	0,2
	2.6.4	Installation and programming of monitoring equipment	0,4
2.7	**Other**		
	2.7.1	Installation of alarms	0,2
	2.7.2	Installation of electrical line in the equipment rooms	0,2
	2.7.3	Building of a cabinet for spares	0,2
3. Installation of auxiliar genset (1st phase)			
3.1		Installation of the genset	0,2
3.2		Wiring genset outlet and installation of electrical box with protections	0,2

Tasks			week
4. Management of the electricity service (1st phase)			
4.1		Organization of the electrical manager	4
4.2		Selection of the governing body for the ectrical manager	1
4.3		Legalization procedures of electrical manager	8
4.4		Approval of the service regulations	1
4.5		Approval of electrical service tariffs	1
4.6		Approval of the contracts of service	1
4.7		Contacting the electrical service with the final users	2
5. Installation of the electric distribution (1st phase)			
5.1		Mounting electric poles	4
5.2		Laying of electric distribution lines	4
5.3		Laying public lighting lines	2
5.4		Installation of street lighting luminaires	1
5.5		Mounting of the control panel for public lighting	1
5.6		Wiring street lamps	1
6. Installation of the housing and inner installation (1st phase)			
6.1		Installation of the housing connection	6
6.2		Installation of the electrical box with housing protections	6
6.3		Installation of the energy meters and dispensers	4
6.4		Installing individual protections boxes	4
6.5		Installation and wiring of the dwellings	6
7. Testing and commissioning (1st phase)			
7.1	**Photovoltaic equipments**		
	7.1.1	Testing and commissioning of batteries	0,2
	7.1.2	Testing and commissioning of PV arrays	0,4
	7.1.3	Testing and commissioning of PV charge controller	0,2
	7.1.4	Testing and commissioning of inverters	0,2
	7.1.5	Testing and commissioning of protections and alarms	0,2
	7.1.6	Testing and commissioning og auxiliar genset	0,2
	7.1.7	Testing and commissioning of monitoring system	0,2
	7.1.8	Commissioning of data transmission system	0,2
	7.1.9	Other checks	0,2
7.2	**Distribustion lines**		
	7.2.1	Testing and commissioning of street lighting lines	0,2
	7.2.2	Testing and commissioning of distribution lines	0,2
	7.2.3	Testing of housing protection fuses	0,4
	7.2.4	Testing of energy counter and dispenser	1
	7.2.5	Testing of inner housing protections	1
	7.2.6	Other checks	0,2
8. Training activities (1st phase)			
8.1		Maintenance training course for local technicians and guards	1
8.2		Advanced maintenance training course for technicians	1
8.3		Training course for governing body of electrical manager	1
8.4		Training course for users	1
9. Reception of the installation (1st phase)			
9.1		Preparation and delivery of maintenance manuals	4
9.2		Reception of the installation: 1st phase	1

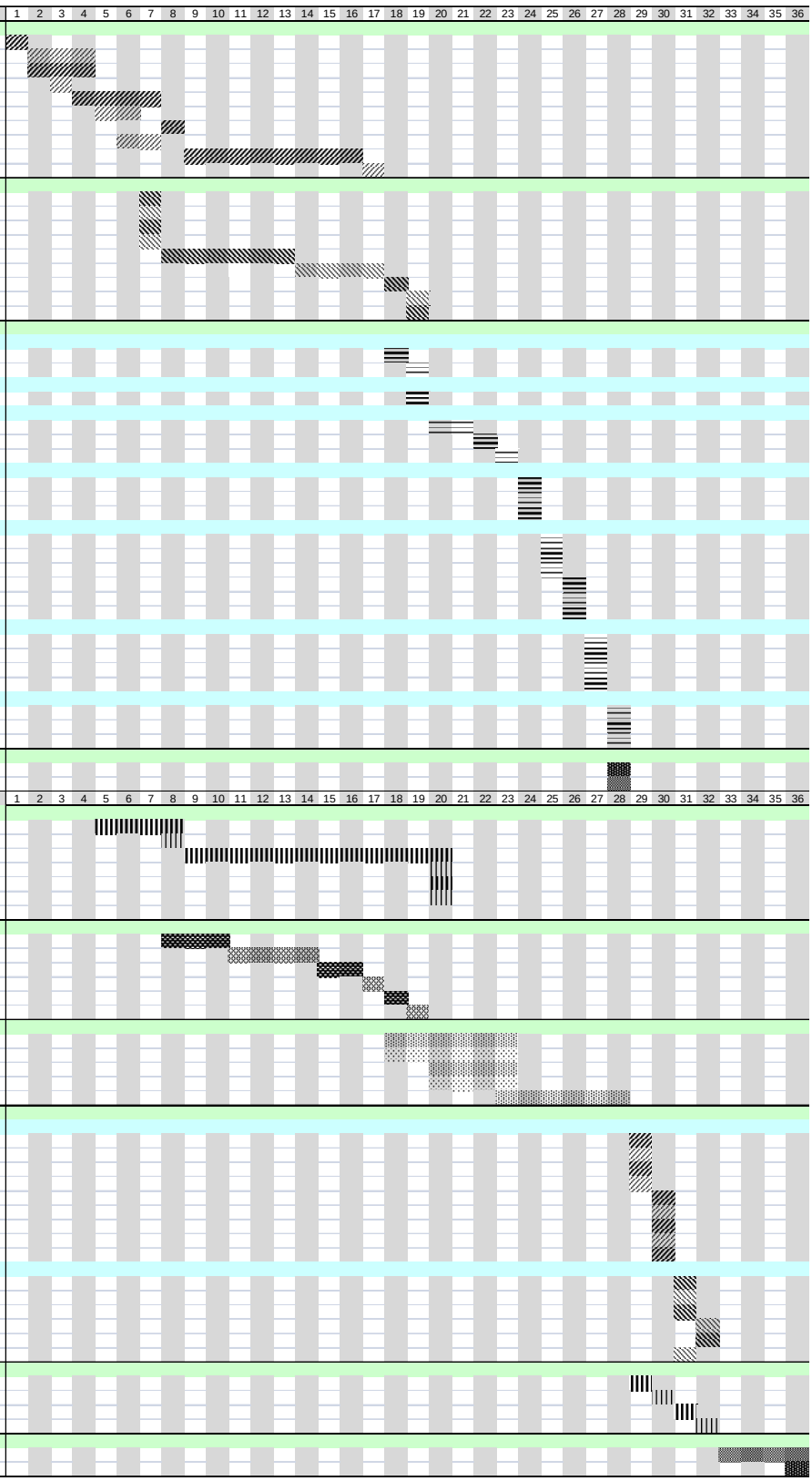
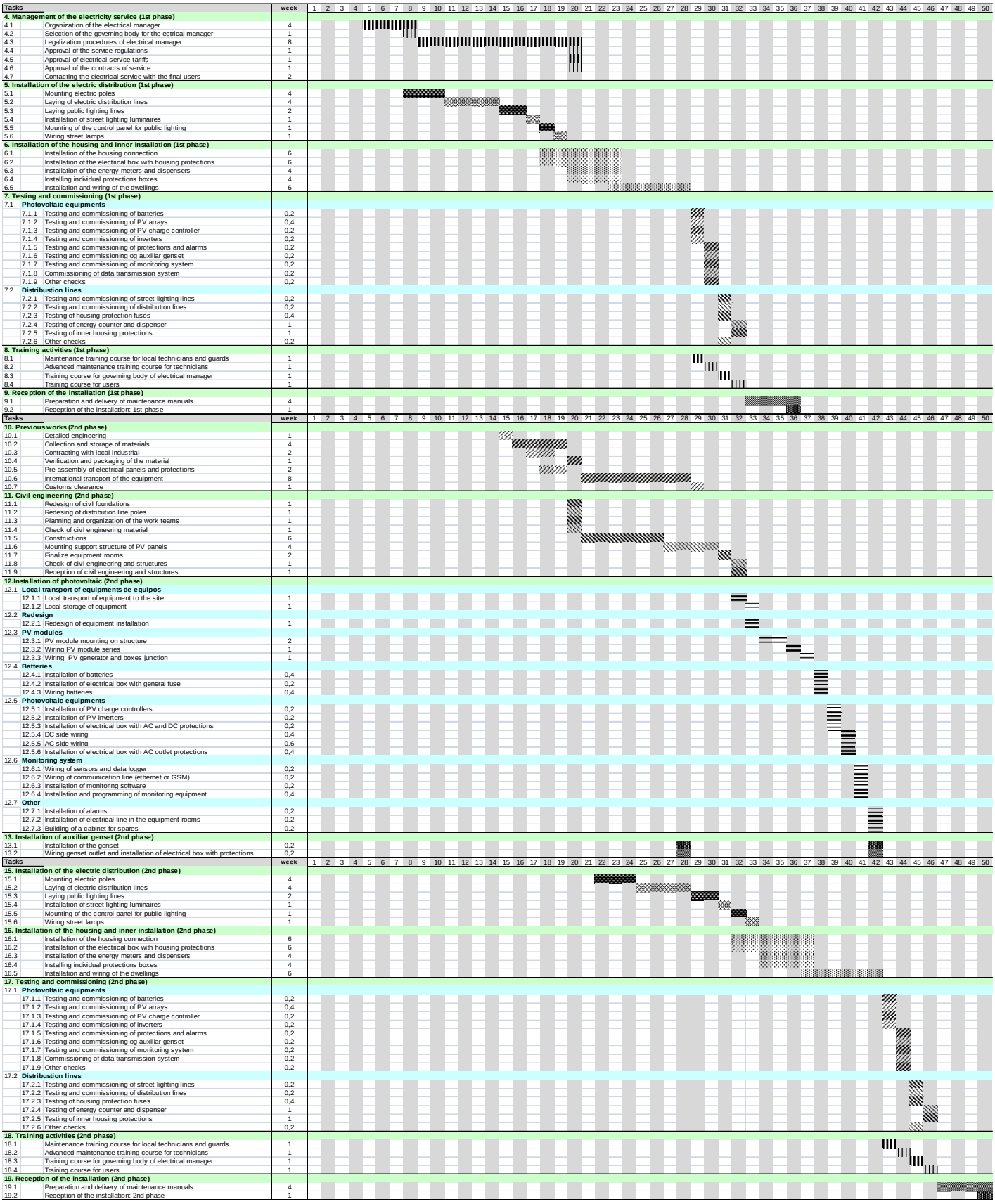


Table 42: Work Plan phase I (TTA)

Total work period estimated: 36 weeks

PHASE II



Tasks			week
4. Management of the electricity service (1st phase)			
4.1		Organization of the electrical manager	4
4.2		Selection of the governing body for the ectrical manager	1
4.3		Legalization procedures of electrical manager	8
4.4		Approval of the service regulations	1
4.5		Approval of electrical service tariffs	1
4.6		Approval of the contracts of service	1
4.7		Contacting the electrical service with the final users	2
5. Installation of the electric distribution (1st phase)			
5.1		Mounting electric poles	4
5.2		Laying of electric distribution lines	4
5.3		Laying public lighting lines	2
5.4		Installation of street lighting luminaires	1
5.5		Mounting of the control panel for public lighting	1
5.6		Wiring street lamps	1
6. Installation of the housing and inner installation (1st phase)			
6.1		Installation of the housing connection	6
6.2		Installation of the electrical box with housing protections	6
6.3		Installation of the energy meters and dispensers	4
6.4		Installing individual protections boxes	4
6.5		Installation and wiring of the dwellings	6
7. Testing and commissioning (1st phase)			
7.1	**Photovoltaic equipments**		
	7.1.1	Testing and commissioning of batteries	0,2
	7.1.2	Testing and commissioning of PV arrays	0,4
	7.1.3	Testing and commissioning of PV charge controller	0,2
	7.1.4	Testing and commissioning of inverters	0,2
	7.1.5	Testing and commissioning of protections and alarms	0,2
	7.1.6	Testing and commissioning og auxiliar genset	0,2
	7.1.7	Testing and commissioning of monitoring system	0,2
	7.1.8	Commissioning of data transmission system	0,2
	7.1.9	Other checks	0,2
7.2	**Distribustion lines**		
	7.2.1	Testing and commissioning of street lighting lines	0,2
	7.2.2	Testing and commissioning of distribution lines	0,2
	7.2.3	Testing of housing protection fuses	0,4
	7.2.4	Testing of energy counter and dispenser	1
	7.2.5	Testing of inner housing protections	1
	7.2.6	Other checks	0,2
8. Training activities (1st phase)			
8.1		Maintenance training course for local technicians and guards	1
8.2		Advanced maintenance training course for technicians	1
8.3		Training course for governing body of electrical manager	1
8.4		Training course for users	1
9. Reception of the installation (1st phase)			
9.1		Preparation and delivery of maintenance manuals	4
9.2		Reception of the installation: 1st phase	1

Tasks			week
10. Previous works (2nd phase)			
10.1		Detailed engineering	1
10.2		Collection and storage of materials	4
10.3		Contracting with local industrial	2
10.4		Verification and packaging of the material	1
10.5		Pre-assembly of electrical panels and protections	2
10.6		International transport of the equipment	8
10.7		Customs clearance	1
11. Civil engineering (2nd phase)			
11.1		Redesign of civil foundations	1
11.2		Redesing of distribution line poles	1
11.3		Planning and organization of the work teams	1
11.4		Check of civil engineering material	1
11.5		Constructions	6
11.6		Mounting support structure of PV panels	4
11.7		Finalize equipment rooms	2
11.8		Check of civil engineering and structures	1
11.9		Reception of civil engineering and structures	1
12.Installation of photovoltaic (2nd phase)			
12.1	**Local transport of equipments de equipos**		
	12.1.1	Local transport of equipment to the site	1
	12.1.2	Local storage of equipment	1
12.2	**Redesign**		
	12.2.1	Redesign of equipment installation	1
12.3	**PV modules**		
	12.3.1	PV module mounting on structure	2
	12.3.2	Wiring PV module series	1
	12.3.3	Wiring PV generator and boxes junction	1
12.4	**Batteries**		
	12.4.1	Installation of batteries	0,4
	12.4.2	Installation of electrical box with general fuse	0,2
	12.4.3	Wiring batteries	0,4
12.5	**Photovoltaic equipments**		
	12.5.1	Installation of PV charge controllers	0,2
	12.5.2	Installation of PV inverters	0,2
	12.5.3	Installation of electrical box with AC and DC protections	0,2
	12.5.4	DC side wiring	0,4
	12.5.5	AC side wiring	0,6
	12.5.6	Installation of electrical box with AC outlet protections	0,4
12.6	**Monitoring system**		
	12.6.1	Wiring of sensors and data logger	0,2
	12.6.2	Wiring of communication line (ethernet or GSM)	0,2
	12.6.3	Installation of monitoring software	0,2
	12.6.4	Installation and programming of monitoring equipment	0,4
12.7	**Other**		
	12.7.1	Installation of alarms	0,2
	12.7.2	Installation of electrical line in the equipment rooms	0,2
	12.7.3	Building of a cabinet for spares	0,2
13. Installation of auxiliar genset (2nd phase)			
13.1		Installation of the genset	0,2
13.2		Wiring genset outlet and installation of electrical box with protections	0,2

Tasks			week
15. Installation of the electric distribution (2nd phase)			
15.1		Mounting electric poles	4
15.2		Laying of electric distribution lines	4
15.3		Laying public lighting lines	2
15.4		Installation of street lighting luminaires	1
15.5		Mounting of the control panel for public lighting	1
15.6		Wiring street lamps	1
16. Installation of the housing and inner installation (2nd phase)			
16.1		Installation of the housing connection	6
16.2		Installation of the electrical box with housing protections	6
16.3		Installation of the energy meters and dispensers	4
16.4		Installing individual protections boxes	4
16.5		Installation and wiring of the dwellings	6
17. Testing and commissioning (2nd phase)			
17.1	**Photovoltaic equipments**		
	17.1.1	Testing and commissioning of batteries	0,2
	17.1.2	Testing and commissioning of PV arrays	0,4
	17.1.3	Testing and commissioning of PV charge controller	0,2
	17.1.4	Testing and commissioning of inverters	0,2
	17.1.5	Testing and commissioning of protections and alarms	0,2
	17.1.6	Testing and commissioning og auxiliar genset	0,2
	17.1.7	Testing and commissioning of monitoring system	0,2
	17.1.8	Commissioning of data transmission system	0,2
	17.1.9	Other checks	0,2
17.2	**Distribustion lines**		
	17.2.1	Testing and commissioning of street lighting lines	0,2
	17.2.2	Testing and commissioning of distribution lines	0,2
	17.2.3	Testing of housing protection fuses	0,4
	17.2.4	Testing of energy counter and dispenser	1
	17.2.5	Testing of inner housing protections	1
	17.2.6	Other checks	0,2
18. Training activities (2nd phase)			
18.1		Maintenance training course for local technicians and guards	1
18.2		Advanced maintenance training course for technicians	1
18.3		Training course for governing body of electrical manager	1
18.4		Training course for users	1
19. Reception of the installation (2nd phase)			
19.1		Preparation and delivery of maintenance manuals	4
19.2		Reception of the installation: 2nd phase	1

Table 43: Work Plan phase II (TTA)

MANAGEMENT MODEL

This activity is particularly critical for the service sustainability in the life cycle years.

Generally speaking this is also an underestimated aspect of the rural electrification projects. For these reasons the contractors underline here its importance and propose a specific work plan activity which will have as objective the following:

- Legal and administrative constitution of the key roles (e.g. operator, owner, regulator etc).
- Associations constitution and capacity building
- Discussion, approval and Legalizations of proposed tariff scheme and pre-contract signature with the final users
- Electricity service operation/administrative rules elaboration and approval
- Users manuals
- Final contract between the operator and the final users

The contractor recommends the project management to follow these main points as well as to foresee the assistance of a professional expats in Chad for at least 3 months in order to start up the legal constitution of the key roles involved and finalize the rest of the proposed point as to complete this phase before the installation will start.

This is not only recommendable but a mandatory for the following steps of the project.

1. CONCLUSIONS

This part resumes the final conclusions, recommendations and opened issues of this study in terms of:

INSTALLATION SYSTEMS SEQUENCE PROPOSAL

PHASE I: Douguia, Mombou

PHASE II: Dourbali, Guelendeng, Mailao

BUDGET CONSTRAINT

The exclusion of the final users due to budget constraint has been very relevant in the case of Dourbali and Guelendeng, controlled in Mailao and Douguia and absent in Mombou.

This aspect is indeed something which can be discussed and analysed with the counterpart but the overall recommendation from the contractors is that for Dourbali and Guelendeng a different project should be foreseen with a funds capacity higher than the one proposed in this project. This would give more possibility for Mailao and Douguia users and will offer a proper technical solution to Dourbali and Douguia. In any case these two communities should have to be studied more in details as the results of this study are not consistent for a wider area project.

The counterpart it has said to be favourable to a solution in this sense.

SIZING RESUMING TABLE

The sizing of the systems has been made taking into account the selected installation systems sequence and the budget constraint for the two phases.

ITEM	1. DOUGUIA	2. MOMBOU	DOURBALI	GUELENDENG	MAILAO
Wp	43010	41630	20010	29670	25070
W (ac)	32000	36000	24000	18000	18000
Wh (dc)	441000	441000	220500	220500	220500
Linear Meter TOT	2000	4800	2400	4600	2400
N° tech houses	1	1	1	1	1
Number of PV Generators	1	1	1	1	1
n° poles	67	160	80	154	80
Number of Final Users	54	138	42	27	35
Number of Lot	1	1	1	1	1
KVA (diesel)	45	45	45	45	45
Internal Installation (basic pack)	54	138	42	27	35

Table 44: resuming installation quantities (TTA)

PUBLIC LIGHTING

The public lighting has been taken into account accordingly to the request provided by the local community representants and effective necessity.

In Dourbali case the public lighting has not been taken into account as the new street project mentioned by the MEP foreseen solar PV installation.

PAYMENT ISSUES

This part is particularly critical.

There are several users which are economically dependent from public entities, ministries etc. In these cases then the tariff fee should be paid with the agreement of the responsible entities.

Then it is recommended a solid agreement between the client and the public entities concerned specifically mentioning that the tariff fee will be paid regularly. In this sense, during the mission, has been agreed with the counterpart to organize specific meetings with the concerned entities in order to clarify this aspect.

This effect is particularly important in the second phase communities, where administrative centres are more concentrated.

In the table below it is represented the economic figures in case that the administrative users will not pay their fees.

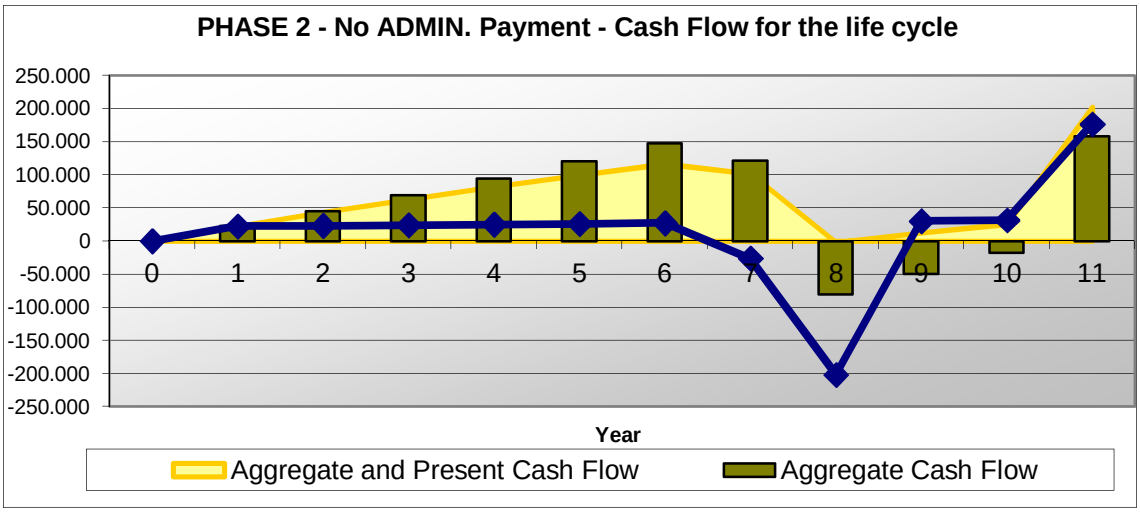


Figure 19: PHASE II cash flow in case of Administrative users lack of payment (TTA)

The project is still sustainable but there are 3 years where the operators will have to pay the O&M costs with its resources.

In terms of Public lighting, the association will have to be in charge for this fee payment. The community itself has been told to be responsible for this part of payment.

MANAGEMENT MODEL

The management model has been proposed on the basis of the water management model of Douguia, a model that is repeated in other communities as well with good results.

It is important for the client to agree with the counterpart on the costs of this model, especially for the part related to technical maintenance activities.

Also it is recommended that any public entities will not be part of this model. Paste experience showed that this kind of model is not durable. This fact has been commented with the counterpart.

TARIFF SELECTION

Tariff proposal by the users is a monthly basis fixed fee which is a mandatory with RE systems.

The fees related to the tariff should be selected in each village or at least per Phase, in order to guarantee the sustainability of that particular system(s).

It should be the same association with external support to choose the tariff fee to be applied.

PV GENERATOR STRUCTURE

During the mission the contractor has studied two scenarios for this important part of the installation.

A standard solution with ground mounted structure and an added value solution with pergola structure and available space below for commercial, public, community activities.

Indeed this last solution is a bit more costly and for this reason has not been taken as the first choice to the client as per respecting the strategy to include the higher number of users in the electricity service connection.

Indeed the added value solution should have to be analysed by the client together with the counterpart because it would be an additional incomes resource for the operator.

O&M HIGH LEVEL SUPPORT

It has been commented and agreed that for the aim of an efficient O&M service at technical and administrative/financial level it is recommended that an external private company was involved, at least for the first years of exercise. In this sense the procedure which is recommended to follow is the public tendering, as already done for other international agency funded projects.

CUSTOM DUTY

During the meeting with the Energy department director, it was said that custom duty should be not be applied. To be confirmed with MEP during the mission to N´Djamena.

PARTICULAR RECOMMENDATIONS

During the inception mission it has been noticed that the responsibility and the duty of the counterpart were not clear to them and to the contractor either.

The recommendation is that, before the starting of the second phase these responsibilities and duty were clarified as well as the costs that these aspects include.

1. PROJECT COSTING

The table below report the project costing of the entire project including the additional service included in the contract as well as the proposed additional tasks explained in this report.

Division between PHASE I and II is also visible with the last column which report the aggregate cost for easy comparison with budget constraint.

TASK	Activity	Objectives	Man Month Costs	Subsistence	Travel And Transportation (USD)	Other costs	Material Installed	Total Activity (USD)	Budget Aggregate (USD)
Inception Mission	**Inception Mission Phase**		71296	10930	6260	1514	0	90000	**$ 90.000**
PHASE I (Douguia and Mombou and accompaining measures)									
Kick-off meeting	**Final Agreement between UNIDO/TTA and Chadian Government on the Installation and the Service to be Implemented.**	- Technical meeting in Vienna after the inception mission. - To agree with the Chadian Counterpart on the Electricity Service Organization to be implemented and the Systems to be Installed.	6193	768	1622	123	0	8705	**$ 98.705**
Organizative scheme	**Operator Creation (5 months expat in Chad)**	- Elaboration of the rules of operator, roles and responsibilities - Legal and administrative Consitución of the Local Association for the 5 villages - Design of the management model of electric service - Preparation of User Manual - Tariff Scheme Approval Contract - Signature of service contracts between the operator and the users. - Privat Investment Installation Mechanism for Large Potential Users	10000	9000	1622	2000	0	37703	**$ 136.408**
1 year accompaining period		- Local installer for 1 year O&M period. Include safety measures. - TTA for supervise the O&M operation and monitoring the performances of the micro-grid.						15000	**$ 151.408**
TOTAL ACCOMPAINING MEASURES									**$ 386.521**
TASK	**Activity**	**Objectives**	**Man Month Costs**	**Subsistence**	**Travel And Transportation (USD)**	**Other costs**	**Material Installed**	**Total Activity (USD)**	**Budget Aggregate**
DOUGUIA	**7. Detailed Design**		4097	0	0	0	0	4097	
	8. Procurement of Material and Equipements		1528	0	0	0	424697	426225	
	9. Installation and Commissioning		10073	1416	4070	335	0	15894	
	10. Local development&Training		2732	408	529	0	0	3669	
	11. Report Preparation and Dissemination		4124	96	102	0	0	4321	
TOTAL DOUGUIA			*22555*	*1920*	*4700*	*335*	*424697*	**$ 454.206**	**$ 605.614**
TASK	**Activity**	**Objectives**	**Man Month Costs**	**Subsistence**	**Travel Costs**	**Other costs**	**Material Installed**		**Budget Aggregate**
MOMBOU	**7. Detailed Design**		4097	0	0	0	0	4097	
	8. Procurement of Material and Equipements		1528	0	0	0	552693	554221	
	9. Installation and Commissioning		10073	1416	4070	335	0	15894	
	10. Local development&Training		2732	408	529	0	0	3669	
	11. Report Preparation and Dissemination		4124	96	102	0	0	4321	
TOTAL MOMBOU			*22555*	*1920*	*4700*	*335*	*552693*	**$ 582.202**	**$ 1.187.816**
	Reserve for Variation to Order								**$ 12.184**
TOTAL PHASE I								**$ 1.110.000**	
TOTAL PHASE I + INCEPTION MISSION PHASE								**$ 1.200.000**	

Table 45: PHASE I project costing (TTA)

PHASE II (Dourbali, Guelendeng, Mailao)									
TASK	Activity	Objectives	Man Month Costs	Subsistence	Travel And Transportation (USD)	Other costs	Material Installed	Total Activity (USD)	Budget Aggregate
DOURBALI	7. Detailed Design		9331	0	0	0	0	9331	
	8. Procurement of Material and Equipements		6112	0	0	0	295586	301698	
	9. Installation and Commissioning		11466	1728	5481	876	0	19551	
	10. Local development&Training		4598	576	1909	463	0	7546	
	11. Report Preparation and Dissemination		4246	96	102	0	0	4443	
DOURBALI			*35752*	*2400*	*7492*	*1339*	*295586*	**$ 342.569**	**$ 1.452.569**
TASK	Activity	Objectives	Man Month Costs	Subsistence	Travel And Transportation (USD)	Other costs	Material Installed	Total Activity (USD)	Budget Aggregate
GUELENDENG	7. Detailed Design		4097	0	0	0	0	4097	
	8. Procurement of Material and Equipements		1528	0	0	0	379007	380535	
	9. Installation and Commissioning		10073	1416	4070	335	0	15894	
	10. Local development&Training		2732	408	529	0	0	3669	
	11. Report Preparation and Dissemination		4124	96	102	0	0	4321	
GUELENDENG			*22555*	*1920*	*4700*	*335*	*379007*	**$ 408.515**	**$ 1.861.084**
TASK	Activity	Objectives	Man Month Costs	Subsistence	Travel Costs	Other costs	Material Installed		Budget Aggregate
MAILAO	7. Detailed Design		4097	0	0	0	0	4097	
	8. Procurement of Material and Equipements		1528	0	0	0	310832	312360	
	9. Installation and Commissioning		10073	1416	4070	335	0	15894	
	10. Local development&Training		2732	408	529	0	0	3669	
	11. Report Preparation and Dissemination		4124	96	102	0	0	4321	
MAILAO			*22555*	*1920*	*4700*	*335*	*310832*	**$ 340.341**	
	Reserve for Variation to Order								**$ 1.408**
TOTAL INSTALLATION PHASE II									**$ 1.092.833**
TOTAL PROJECT									**$ 2.292.833**

Table 46: PHASE II project costing (TTA)

As it can be noticed the total revised budget proposal is about 2,291,602 USD which is slightly below of the budget proposal in the contractor's economic offer.

In the following tables the details costs for material and installation is showed. These include also the additional equipment that the contractors recommend for installation and which were not included in the TORs of the tender.

DOURBALI			Revised budget		Tender budget	
ITEMS	Unit	Tender Unit costs (USD)	Quantity	Total costs (USD)	Quantity	Total costs (USD)
1: PV GENERATION	Wp	1,68	35190	59097	50000	83968
2: STRUCTURE	Wp	0,37	35190	12906	50000	18338
3: PV PLANT CABLING	Wp	0,09	35190	3217	50000	4571
4: POWER TRANSFORMATION	W (ac)	1,10	24000	26295	24000	26295
5: STORAGE	Wh (dc)	0,07	368480	24492	619200	41157
6: DC PROTECTION	Wh (dc)	0,01	368480	2509	619200	4216
7: AC PROTECTION	W (ac)	0,21	24000	4972	24000	4972
8: CABLING AND DISTRIBUTION LINE						
8.1 Cabling PV generator	Wp	0,07	35190	2310	50000	3282
8.2 Battery Cabling	Wh (dc)	0,00	368480	1245	619200	2092
8.3 AC Cabling	W (ac)	0,06	24000	1324	24000	1324
8.4 Distribution line	Linear Meter	22,50	2700	60737	6500	146218
9: EARTHING						
9.1 Electronic devices	Number of Tech houses	451,77	1	452	1	452
9.2 PV Generator	Number of Generators	593,77	1	594	1	594
9.3 Final users installation	Number of Dom. Users	58,65	59	3460	140	8211
9.4 Distribution Line	nº poles	40,76	90	3668	250	10190
10: SURGE DESCHARGER						
10.1 PV Generator	Number of Generators	2417,53	1	2418	1	2419
10.2 Power tranformation devices	Number of Tech houses	1039,53	1	1040	1	1039
11: DOMESTIC WIRING AND INSTALLATION	Number of Final Users	467,67	62	28996	140	65474
12: SPARE PARTS	Wp	0,12	35190	4373	50000	6213
13: SHIPPING AND FINAL DESTINATON TRANSPORTATION	Wp	0,93	35190	32597	50000	46315
14: INSTALLATION	Wp	0,70	35190	24638	50000	35007
15: TRAINING CURSE	Number of Lot	3584,07	1	3584	1	3584
ADDITIONAL ITEMS		New Unit costs		**304921**		**515930**
16: BUILDING	Ut	50357	1	50357	-	
17: MONITORING	Ut	1782	1	1782	-	
18: AUXILIAR GENSET	KVA	318	40	12729	-	
19. PUBLIC LIGHTING	Nº Poles	270	0	0	-	
TOTAL MATERIAL (USD)				**369789**		

Table 47: Dourbali project costing (TTA)

Dourbali, which in the tender was taken as single phase village for installation it can be appreciated the unit costs comparison with the new proposal presented here.

DOUGUIA			Revised budget	
ITEMS	Unit	Tender Unit costs (USD)	Quantity	Total costs (USD)
1: PV GENERATION	Wp	1,68	43010	72229
2: STRUCTURE	Wp	0,37	43010	15774
3: PV PLANT CABLING	Wp	0,09	43010	3932
4: POWER TRANSFORMATION	W (ac)	1,10	24000	26250
5: STORAGE	Wh (dc)	0,07	441000	29312
6: DC PROTECTION	Wh (dc)	0,01	441000	3003
7: AC PROTECTION	W (ac)	0,21	24000	4972
8: CABLING AND DISTRIBUTION LINE				
8.1 Cabling PV generator	Wp	0,07	43010	2823
8.2 Battery Cabling	Wh (dc)	0,00	441000	1490
8.3 AC Cabling	W (ac)	0,06	24000	1324
8.4 Distribution line	Linear Meter	22,50	2000	44990
9: EARTHING				
9.1 Electronic devices	Number of Tech houses	451,77	1	452
9.2 PV Generator	Number of Generators	593,77	1	594
9.3 Final users installation	Number of Dom. Users	58,65	54	3167
9.4 Distribution Line	nº poles	40,76	67	2731
10: SURGE DESCHARGER				
10.1 PV Generator	Number of Generators	2417,53	1	2418
10.2 Power tranformation devices	Number of Tech houses	1039,53	1	1040
11: DOMESTIC WIRING AND INSTALLATION	Number of Final Users	467,67	57	26657
12: SPARE PARTS	Wp	0,12	43010	5344
13: SHIPPING AND FINAL DESTINATON TRANSPORTATION	Wp	0,93	43010	39840
14: INSTALLATION	Wp	0,70	43010	30113
15: TRAINING CURSE	Number of Lot	3584,07	1	3584
ADDITIONAL ITEMS		New Unit costs		
16: BUILDING	Ut	51192	1	51192
17: MONITORING	Ut	1782	1	1782
18: AUXILIAR GENSET	KVA	318	45	14320
19. PUBLIC LIGHTING	Nº Poles	270	19	5132
TOTAL MATERIAL (USD)				**394465**

Table 48: Douguia project costing (TTA)

MOMBOU			Revised budget	
ITEMS	Unit	Tender Unit costs (USD)	Quantity	Total costs (USD)
1: PV GENERATION	Wp	1,68	41630	69912
2: STRUCTURE	Wp	0,37	41630	15268
3: PV PLANT CABLING	Wp	0,09	41630	3806
4: POWER TRANSFORMATION	W (ac)	1,10	36000	26250
5: STORAGE	Wh (dc)	0,07	441000	29312
6: DC PROTECTION	Wh (dc)	0,01	441000	3003
7: AC PROTECTION	W (ac)	0,21	36000	7458
8: CABLING AND DISTRIBUTION LINE				
8.1 Cabling PV generator	Wp	0,07	41630	2732
8.2 Battery Cabling	Wh (dc)	0,00	441000	1490
8.3 AC Cabling	W (ac)	0,06	36000	1986
8.4 Distribution line	Linear Meter	22,50	4800	107976
9: EARTHING				
9.1 Electronic devices	Number of Tech houses	451,77	1	452
9.2 PV Generator	Number of Generators	593,77	1	594
9.3 Final users installation	Number of Dom. Users	58,65	138	8093
9.4 Distribution Line	nº poles	40,76	160	6521
10: SURGE DESCHARGER				
10.1 PV Generator	Number of Generators	2417,53	1	2418
10.2 Power tranformation devices	Number of Tech houses	1039,53	1	1040
11: DOMESTIC WIRING AND INSTALLATION	Number of Final Users	467,67	141	65942
12: SPARE PARTS	Wp	0,12	41630	5173
13: SHIPPING AND FINAL DESTINATON TRANSPORTATION	Wp	0,93	41630	38562
14: INSTALLATION	Wp	0,70	41630	29147
15: TRAINING CURSE	Number of Lot	3584,07	1	3584
ADDITIONAL ITEMS		New Unit costs		
16: BUILDING	Ut	48872	1	48872
17: MONITORING	Ut	2672	1	2672
18: AUXILIAR GENSET	KVA	318	45	14320
19. PUBLIC LIGHTING	Nº Poles	270	19	5132
TOTAL MATERIAL (USD)				**501714**

Table 49: Mombou project costing (TTA)

GUELENDENG			Revised budget	
ITEMS	Unit	Tender Unit costs (USD)	Quantity	Total costs (USD)
1: PV GENERATION	Wp	1,68	34270	57552
2: STRUCTURE	Wp	0,37	34270	12569
3: PV PLANT CABLING	Wp	0,09	34270	3133
4: POWER TRANSFORMATION	W (ac)	1,10	24000	26250
5: STORAGE	Wh (dc)	0,07	225000	14955
6: DC PROTECTION	Wh (dc)	0,01	225000	1532
7: AC PROTECTION	W (ac)	0,21	24000	4972
8: CABLING AND DISTRIBUTION LINE				
8.1 Cabling PV generator	Wp	0,07	34270	2249
8.2 Battery Cabling	Wh (dc)	0,00	225000	760
8.3 AC Cabling	W (ac)	0,06	24000	1324
8.4 Distribution line	Linear Meter	22,50	4700	105727
9: EARTHING				
9.1 Electronic devices	Number of Tech houses	451,77	1	452
9.2 PV Generator	Number of Generators	593,77	1	594
9.3 Final users installation	Number of Dom. Users	58,65	35	2053
9.4 Distribution Line	nº poles	40,76	157	6399
10: SURGE DESCHARGER				
10.1 PV Generator	Number of Generators	2417,53	1	2418
10.2 Power tranformation devices	Number of Tech houses	1039,53	1	1040
11: DOMESTIC WIRING AND INSTALLATION	Number of Final Users	467,67	38	17772
12: SPARE PARTS	Wp	0,12	34270	4258
13: SHIPPING AND FINAL DESTINATON TRANSPORTATION	Wp	0,93	34270	31744
14: INSTALLATION	Wp	0,70	34270	23994
15: TRAINING CURSE	Number of Lot	3584,07	1	3584
ADDITIONAL ITEMS		New Unit costs		
16: BUILDING	Ut	47547	1	47547
17: MONITORING	Ut	1504	1	1504
18: AUXILIAR GENSET	KVA	318	45	14320
19. PUBLIC LIGHTING	Nº Poles	270	31	8373
TOTAL MATERIAL (USD)				**397074**

Table 50: Guelendeng project costing (TTA)

MAILAO			Revised budget	
ITEMS	Unit	Tender Unit costs (USD)	Quantity	Total costs (USD)
1: PV GENERATION	Wp	1,68	30130	50599
2: STRUCTURE	Wp	0,37	30130	11051
3: PV PLANT CABLING	Wp	0,09	30130	2755
4: POWER TRANSFORMATION	W (ac)	1,10	24000	26250
5: STORAGE	Wh (dc)	0,07	225000	14955
6: DC PROTECTION	Wh (dc)	0,01	225000	1532
7: AC PROTECTION	W (ac)	0,21	24000	4972
8: CABLING AND DISTRIBUTION LINE				
8.1 Cabling PV generator	Wp	0,07	30130	1978
8.2 Battery Cabling	Wh (dc)	0,00	225000	760
8.3 AC Cabling	W (ac)	0,06	24000	1324
8.4 Distribution line	Linear Meter	22,50	2500	56238
9: EARTHING				
9.1 Electronic devices	Number of Tech houses	451,77	1	452
9.2 PV Generator	Number of Generators	593,77	1	594
9.3 Final users installation	Number of Dom. Users	58,65	41	2405
9.4 Distribution Line	nº poles	40,76	84	3424
10: SURGE DESCHARGER				
10.1 PV Generator	Number of Generators	2417,53	1	2418
10.2 Power tranformation devices	Number of Tech houses	1039,53	1	1040
11: DOMESTIC WIRING AND INSTALLATION	Number of Final Users	467,67	44	20578
12: SPARE PARTS	Wp	0,12	30130	3744
13: SHIPPING AND FINAL DESTINATON TRANSPORTATION	Wp	0,93	30130	27909
14: INSTALLATION	Wp	0,70	30130	21095
15: TRAINING CURSE	Number of Lot	3584,07	1	3584
ADDITIONAL ITEMS		New Unit costs		
16: BUILDING	Ut	45525	1	45525
17: MONITORING	Ut	1504	1	1504
18: AUXILIAR GENSET	KVA	318	45	14320
19. PUBLIC LIGHTING	Nº Poles	270	23	6212
TOTAL MATERIAL (USD)				**327215**

Table 51: Mailao project costing (TTA)

2. PROPOSED SOCIO-ECONOMIC DEVELOPMENT INDICATORS

Accordingly to social-economic context analysed by the contractor during the mission, a set of indicators have been identified in order to follow up the impact of the electrification object of the project, on the community level of development.

12.1 Description

Development Indicators are designed to measure the quality of life in communities and their progress toward development in meeting a range of economic, social, and environmental goals.

Indicators can be used for many purposes such monitoring the progress of the project, they can help to show whether the project is moving in the right direction, to evaluate the project and know the impact in the communities.

Development Indicators and its Evaluation are interesting for all the stakeholders involved in the project: funders, policymakers, beneficiaries, local installer and Trama TecnoAmbiental because it allows demonstrating the impact of the program and generates “lessons learned” for future projects. In this project it takes more relevant importance as it is a pilot project in Chad.

There are different approaches to defining Development Indicators. Despite the large number of renewable energy projects for rural electrification, there aren’t common methodologies used to evaluate the projects and there are different approaches to determinate the Development Indicators: by uses (collective, productive, domestic), by sustainability, by sustainability and project specific uses and by type of indicators. The Development Indicators proposed follows the approaches by uses, recommended by the Monitoring and Evaluation in Energy for Development International Working Group.

Usually indicators are defined within the Logical Framework design, but this project hasn't one. The proposed indicators are focused in the impact of the project and are expressed in quantitative and qualitative manner.

12.2 Field mission remarks

Based on the field mission to the 5 towns involved, the project can have a great impact and benefit the population in the following main sectors:

Education

Electricity has positive effects on education for children and adults:

- Possibility to start Adult Literacy lessons for those people without access to education with evening courses in the schools
- Improve the quality of education with the application of new methods of learning (computers, photocopy, etc.)
- With outdoor lighting in the schools, children can go there to study at evening time; it means more hours of study per children with good implications for their education
- Improved educational conditions in the schools because of the light and fans in the classrooms

Health

Most of the Health Centers visited don't have electricity or if there is a generator, it works few hours per day. There are several benefits regarding Health:

- Improve the quality of medical activity and monitoring of patients in the Health Centers
- Improve comfort in medical facilities for patients and medical staff
- Use electric refrigerators instead of petroleum's to improve the preservation of products
- Possibility to have laboratories in health centers and make more complete medical tests
- Improving the overall health of the population by less pollution due to the use of generators or oil lamps (less respiratory infections and eyes problems)

Water Supply

It has not been studied the option to mechanize hand pumps in the towns, but regarding the public, community and private water supply systems distribution, there can be some improvements:

- Increase the quantity of pumping water with more hours of service
- Decrease the price of the water

Administrative and Community buildings:

The service offered to the citizens can be improved through:

- Better working conditions in the buildings
- Improving community services
- Access to new ICT services
- More activities at evening time can be offered to the population

Religious Buildings

The comfort can be improved with the lights, fans, speakers, etc.

Public Lighting

Public electrification can increase the sense of comfort and protection among the population.

- Decrease the number of robberies in the towns
- Increase the sense of security
- Increase and facilitate meetings among the people, ceremonies and strengthen the sense of the groups.

Communication

Information can be improved through TV, Radio and internet. People may be more informed about what goes on in their country, access to development programs of agriculture, health, livestock, business development, awareness campaigns, etc.

- Better access to the information

Environment

With the renewable energy system, there could be:

- Less environmental pollution and less noise pollution if it dismiss the use of generators and battery lamps
- Improve the environment with less use of batteries for lighting

Productive Activities

Electricity plays an important role in the development and profitability of business productivity; they can operate more efficiently and for longer periods of time.

Better energy service can produce the following general impacts:

In particular:

- Agriculture and fishing groups:
    - Improve the irrigation systems
    - Improve storage time and fresh conservation of the products
    - Increase the productivity
    - Improve the quality of the product sold

- Productive activities:
    - Increase the product quality
    - Increase the productivity
    - Increase the diversification of the products
    - Better conservation of fresh products

Households Lighting

This option is only estimated in Mombou. There are lots of benefits and the life of a family can change a lot with access to home energy and the living standards can improve.

Most of the benefits have been already explained above: to have light to study at home, opportunity to read more, access to information with TV and radio, which can also provide entertainment, possibility to have access to refrigeration and to charge cell phones, do different activities at home, improve health for less pollution, etc.

The proposal for Development Indicators has been defined based on all these benefits in the towns.

12.3 Proposal for Development Indicators

Development Indicators have been identified after the field mission thanks to the data obtained in meetings with local leaders and potential users. They will allow the evaluation of the project impact in the towns.

Development Indicators for Collective Uses

Type of collective use	Use	Quantifiable indicator and observables	Qualitative Indicator
Health Centre	Lighting	Nº lamps and location	- Quality of patient follow-up - Quality of medical activity - Comfort for patients and staff
	Computing	Nº computers and uses	
	Medical equipment	Nº electrical equipment, type and Use	
	Refrigeration & freezing	Nº of equipment and use	
	Ventilation	Nº of fans and use	
School	Lighting	Nº lamps and location	- Quality of teaching - Quality and quantity of work done by pupils - New possibilities in teaching methods
	Ventilation	Nº of fans and use	
	Type of lessons	Nº of hours of teaching and type (children, adults)	
	Electrical equipment	Nº computers and uses	
		Nº photocopiers and uses	
		Other equipment	
Public lighting	Public lighting	Nbr lamps and location	- Safety and comfort outside
Pumping	Drinking water	Nº liters pumped	- Improvement in the water service - Decrease the price per liter
		Price per liter paid	
Administrative buildings	Lighting	Nº lamps and location	- Improvement in administration and management of information
	Computing	Nº computers and uses	
	Ventilation	Nº of fans and use	
Community buildings	Lighting	Nº lamps and location	- Better community services - More comfortability - Access to new services
	Electrical equipment (Computers, DVD, etc.)	Nº equipment and use	
	Ventilation	Nº of fans and use	
Religious buildings	Lighting	Nº lamps and location	- More Comfort
	Ventilation	Nº of fans and use	
	Other equipment (speakers…)	Nº equipment and use	

Table 52: Development Indicators for Collective Uses (TTA)

Development Indicators for Productive Uses

Type of Productive Use	Use	Quantifiable indicator and observables	Qualitative Indicator
- Associations (agriculture, fishing, women, etc.)	Pumping (irrigation & drinking water)	Nº of liters pumped / Nº hours x day Price x liter paid	- Improvement of the quality of products sold - Better conservation of the fresh products - Increase the productivity - Diversification of products - Increase / Decrease Working hours per day
- Private Water Business	Electrical Machines	Nº of machines, type and utilization	- Increase the nº of workers per business - Increase income generation, more benefits
- Commercial Activities	Refrigeration, freezer	Nº refrigerator, type of products refrigerated or frozen	
- Entertainment and leisure activities	Lighting	Nº lamps and location	
	Ventilation	Nº of fans and use	
	Electrical equipment (computer, DVD, etc.)	Nº equipment and use	

Table 53: Development Indicators for Productive Uses (TTA)

Development Indicators for Domestic Use

Energy use	Quantifiable indicator and Observables	Qualitative Indicator
	Nº and type of lighting points in households	
Lighting	Average number of hours of use	- Lighting quality improvement
Ventilation	Presence of other lighting sources	- Additional income generated
Refrigeration	Activities using electric lighting	- Education: improved possibility for home education
Domestic Appliances	Average monthly expenses (for each type of lighting)	- Indoor air pollution reduction
Information technology	Average monthly expenses before electrification	- Food product choice enlargement
	Number and type of lighting sources used before electrification	- Living standards improvement
	Nº and type of refrigerators	- Informational access
	Daily time of refrigerator usage	- Comfort improvement
	Household product choice before and after the access to electric refrigeration	- Household budget modification (lighting, others)
	N of ventilators, type and use	
	Nº of appliances, type and use (TV, radio, DVD, Computer, Internet access, cell phone batteries, etc.)	

Table 54: Development Indicators for Domestic Uses (TTA)

12.4 Working Methodology

The proposed working methodology for the definition of the baseline and the evaluation process is described below:

1. Final definition of indicators once selected the final users, to get indicators considered most appropriate to assess the project's impact (*indicator sheets*)

2. Definition of the strategy for the Baseline, data collection at the beginning or during the project implementation to gather the initial situation and values of the indicators.

3. Baseline Survey: structured data questionnaires that include a set of specific questions related to all the variables under study. It allows to get more accurate information of the target population and to set the starting point to compare the results of the intervention during the final and impact evaluations of the project.

4. Final evaluation: It takes place at the end of the project execution, based on interviews with community members, written surveys and physical inspection of the installations. Results should be compared with the Baseline data.

5. Impact Assessment: takes place a few years after completion of the project, when it is expected that their activities have produced their full impact. The proposal is to do the assessment 2 years after the project finalization.

   The aims of this assessment are:

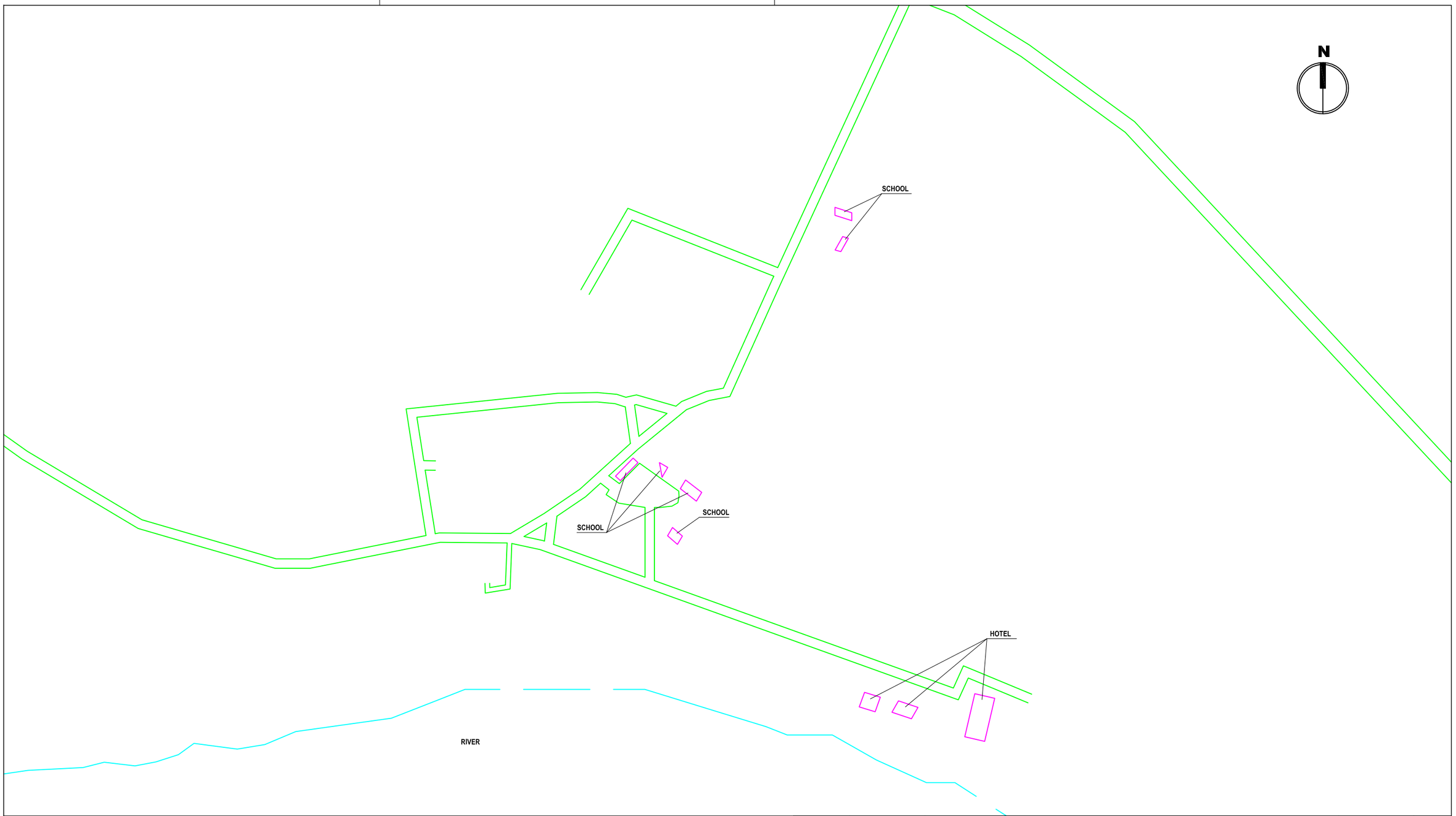
   - Assess the achievement of the overall project results, in terms of efficiency, outputs, outcomes and impact, and
   - Get lessons for future planning, that is, for the design or formulation, appraisal, implementation and monitoring and evaluation of development activities to be undertaken in the future.

   Many of the impact indicators will not be visible when the project is complete, and the impacts identified in the final evaluation result can be transient.

   It is recommended biannual site evaluation visits.

ANNEX

A. DRAWINGS



DOUGIA:
LATITUDE: 12,6406º N
LONGITUDE: 14,8283º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

LOCATION

DOUGUIA

Promoted: UNIDO

Approved:

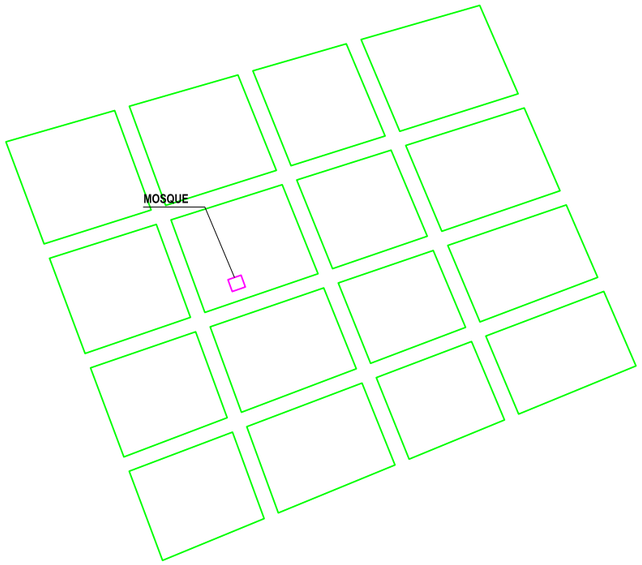
Engineer Xavier Vallvé

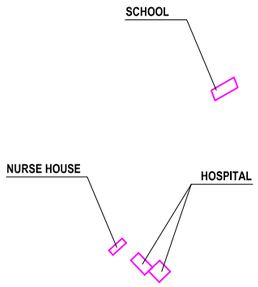
Design

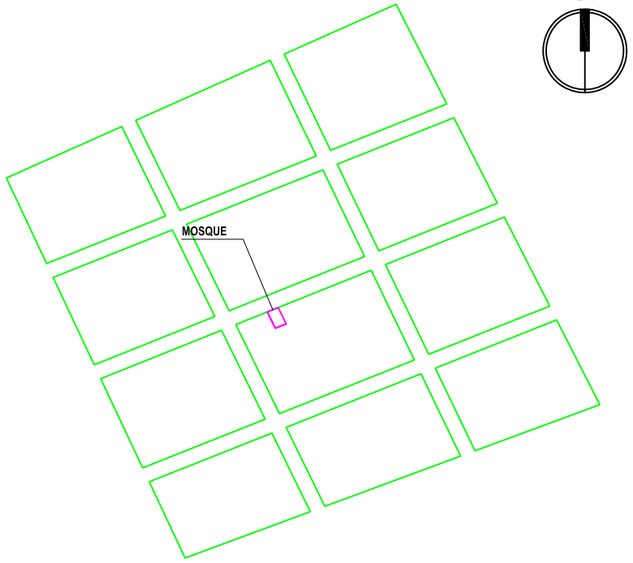
tta Trama TecnoAmbiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 1.1.1–R00







MOMBOU:
LATITUDE: 13,4135º N
LONGITUDE: 15,6406º E

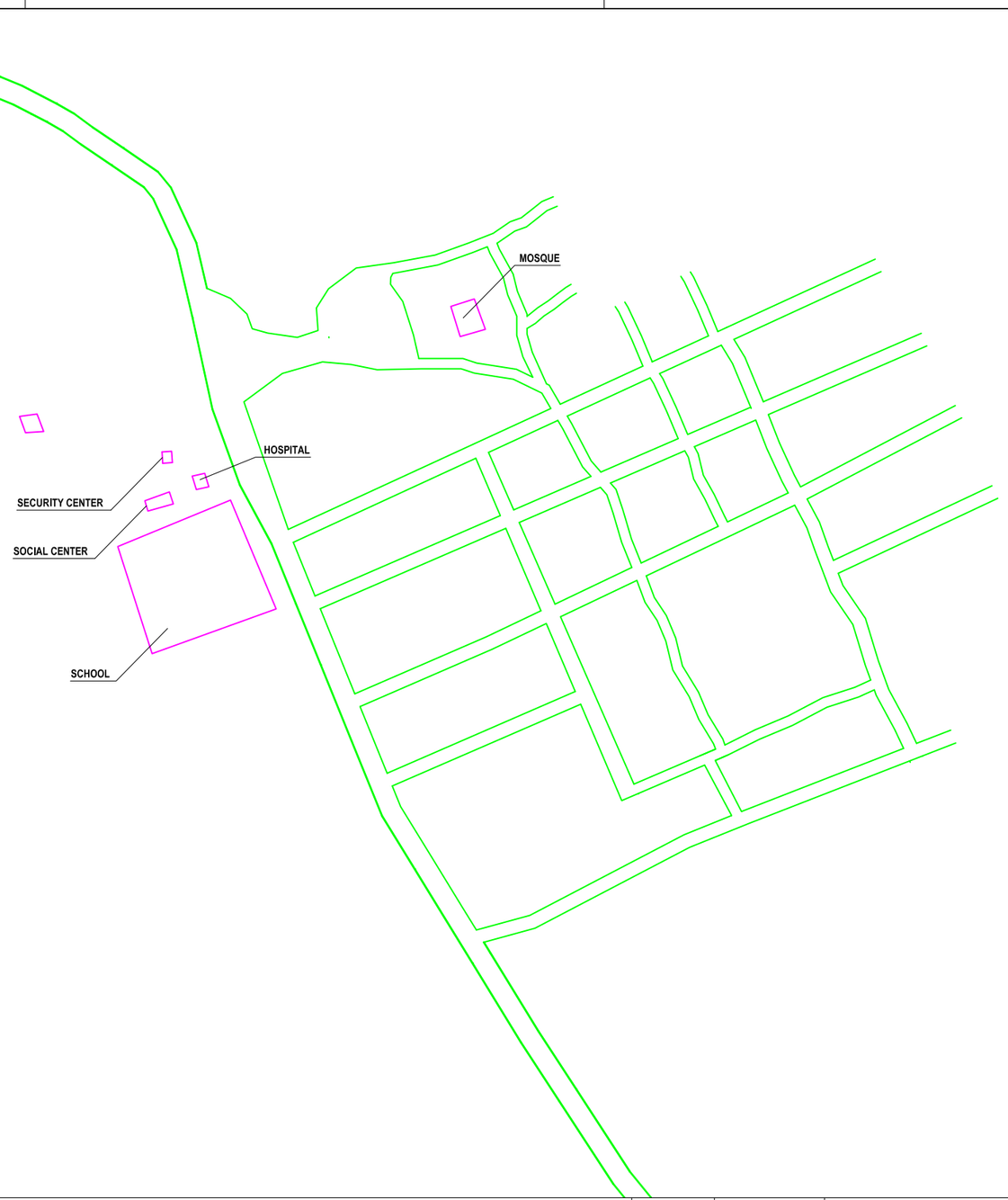
R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name: LOCATION

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 1.2.1–R00



DOURBALI:
LATITUDE: 11,8º N
LONGITUDE: 15,87º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name: LOCATION

DOURBALI

Promoted: UNIDO

Approved: Engineer Xavier Vallvé

Design: tta Trama TecnoAmbiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 1.3.1–R00

PART A:

PART B:

N

GUELENDENG:
LATITUDE: 10,92º N
LONGITUDE: 15,87º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

LOCATION

GUELENDENG

Promoted:

Approved:

Engineer Xavier Vallvé

Design

www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:10000

Drawing Number: 1.4.1–R00

GUELENDENG:
LATITUDE: 10,92º N
LONGITUDE: 15,87º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

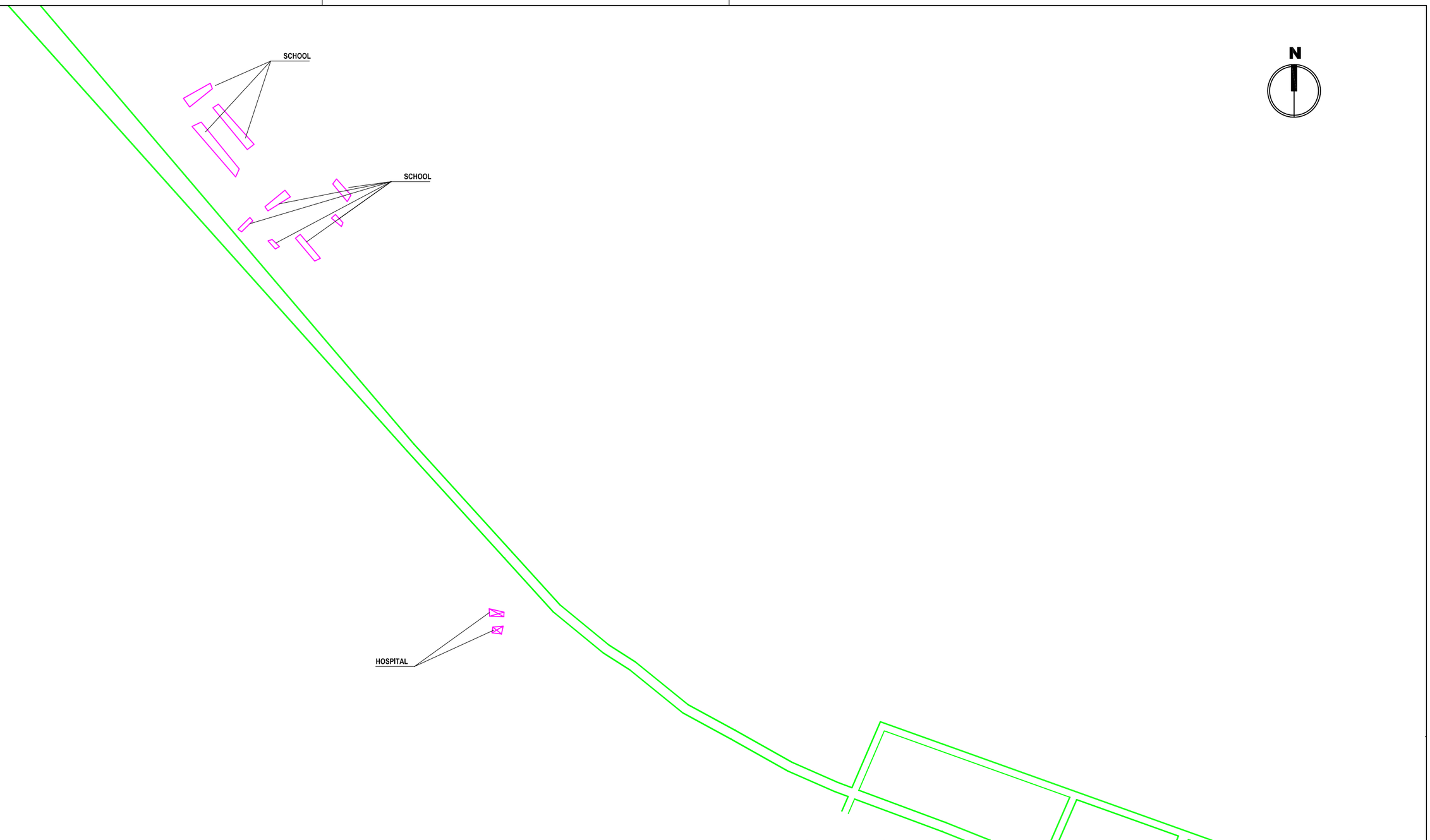
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

LOCATION PART B

GUELENDENG

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 1.4.2–R00



GUELENDENG:
LATITUDE: 10,92º N
LONGITUDE: 15,87º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

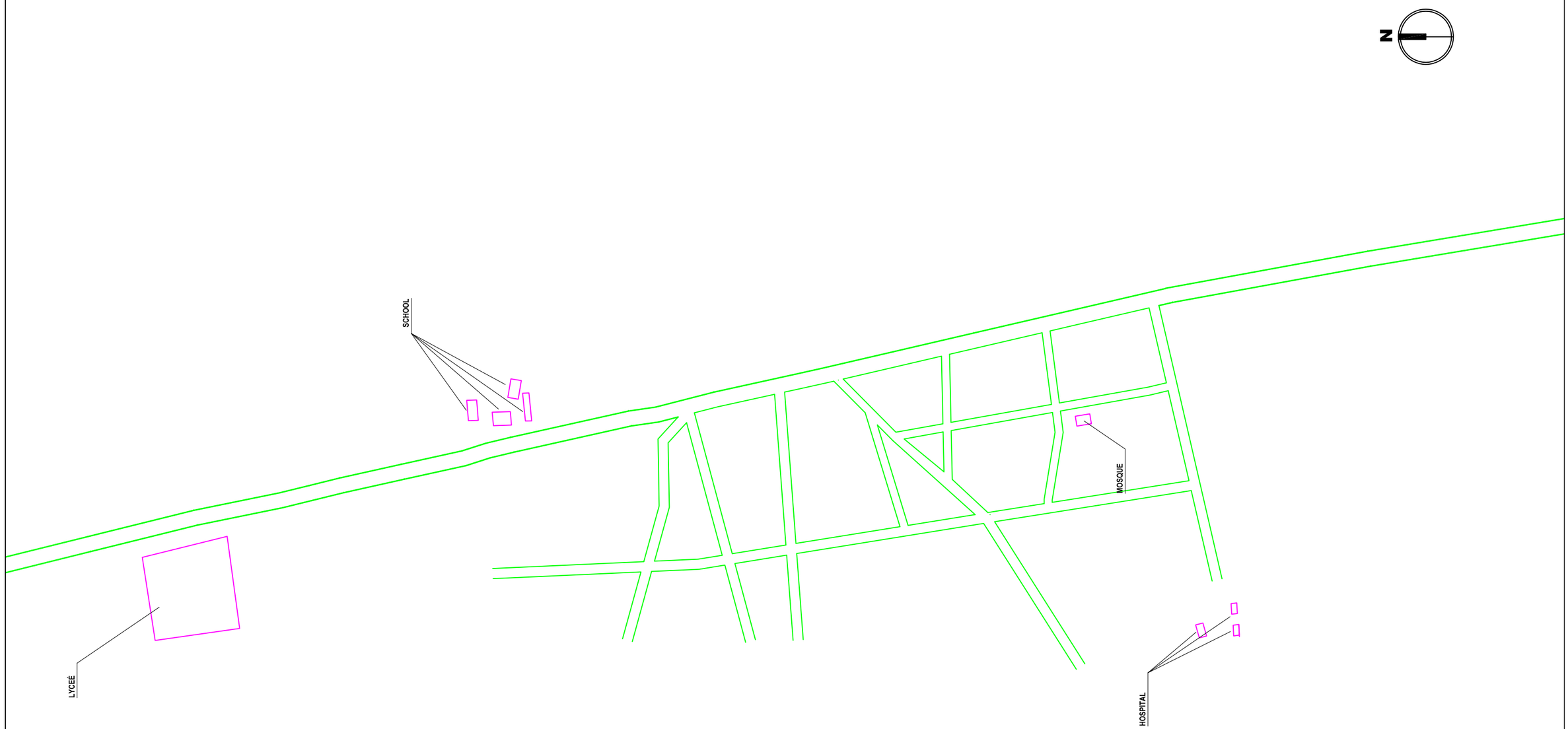
LOCATION PART A

GUELENDENG

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000

Drawing Number:

1.4.3–R00



MAILAO:
LATITUDE: 11,58º N
LONGITUDE: 15,28º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

LOCATION

MAILAO

Promoted: UNIDO

Approved:

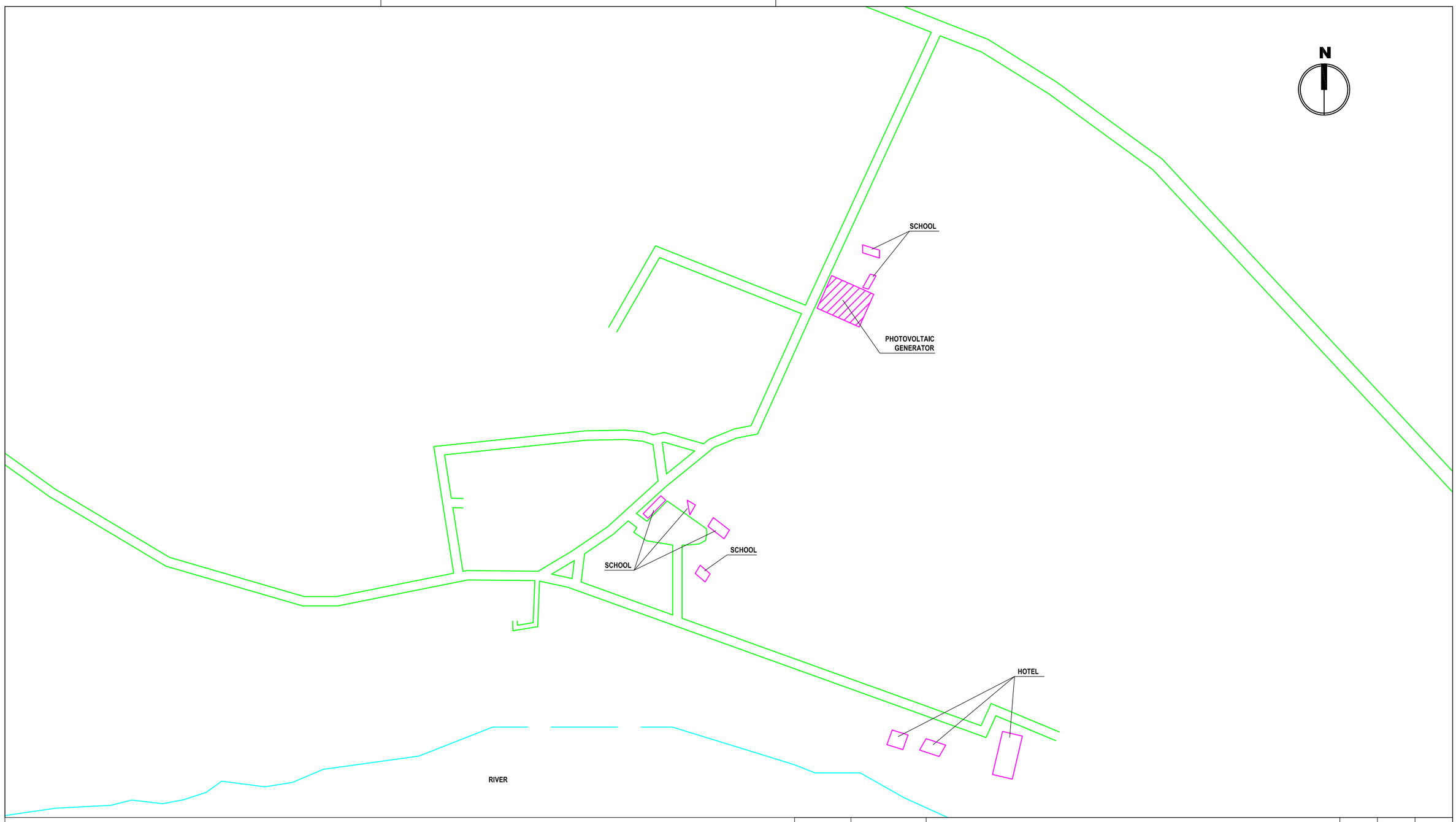
Engineer Xavier Vallvé

Design

tta tramatecnoambiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 1.5.1–R00



DOUGIA:
LATITUDE: 12,6406º N
LONGITUDE: 14,8283º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR LOCATION

DOUGUIA

Promoted: UNIDO

Approved:

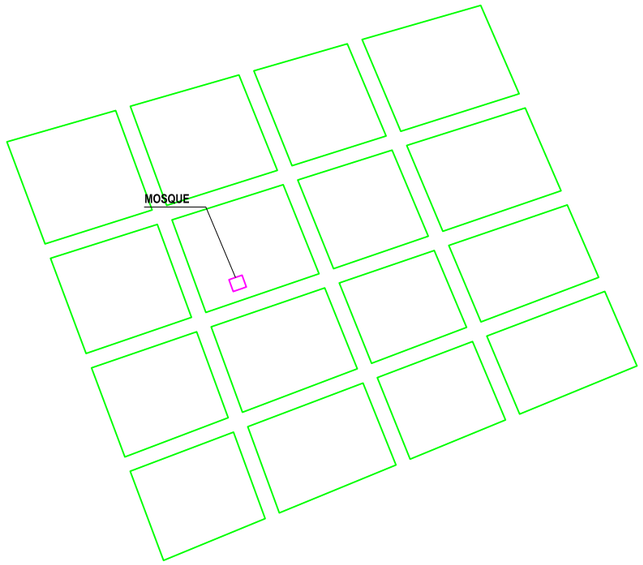
Engineer Xavier Vallvé

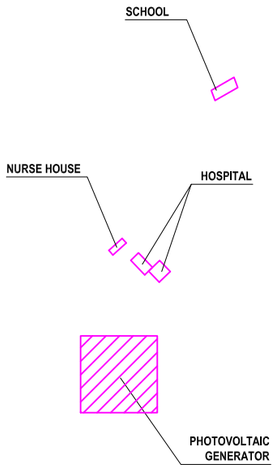
Design

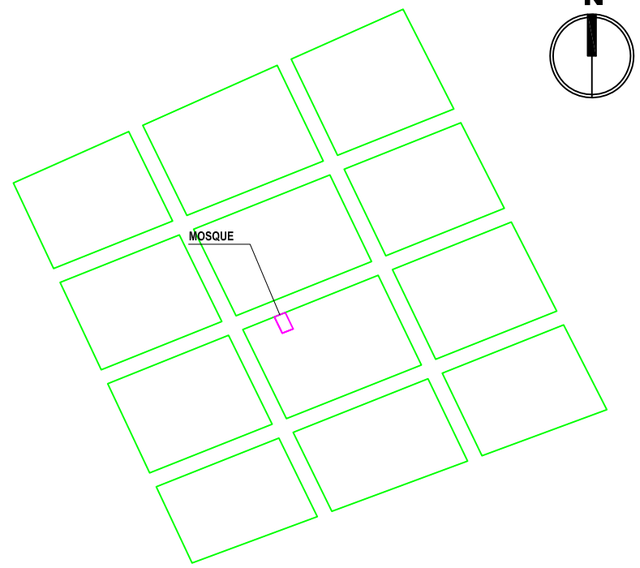
tta Trama TecnoAmbiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 2.1.1–R00







MOMBOU:
LATITUDE: 13,4135º N
LONGITUDE: 15,6406º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

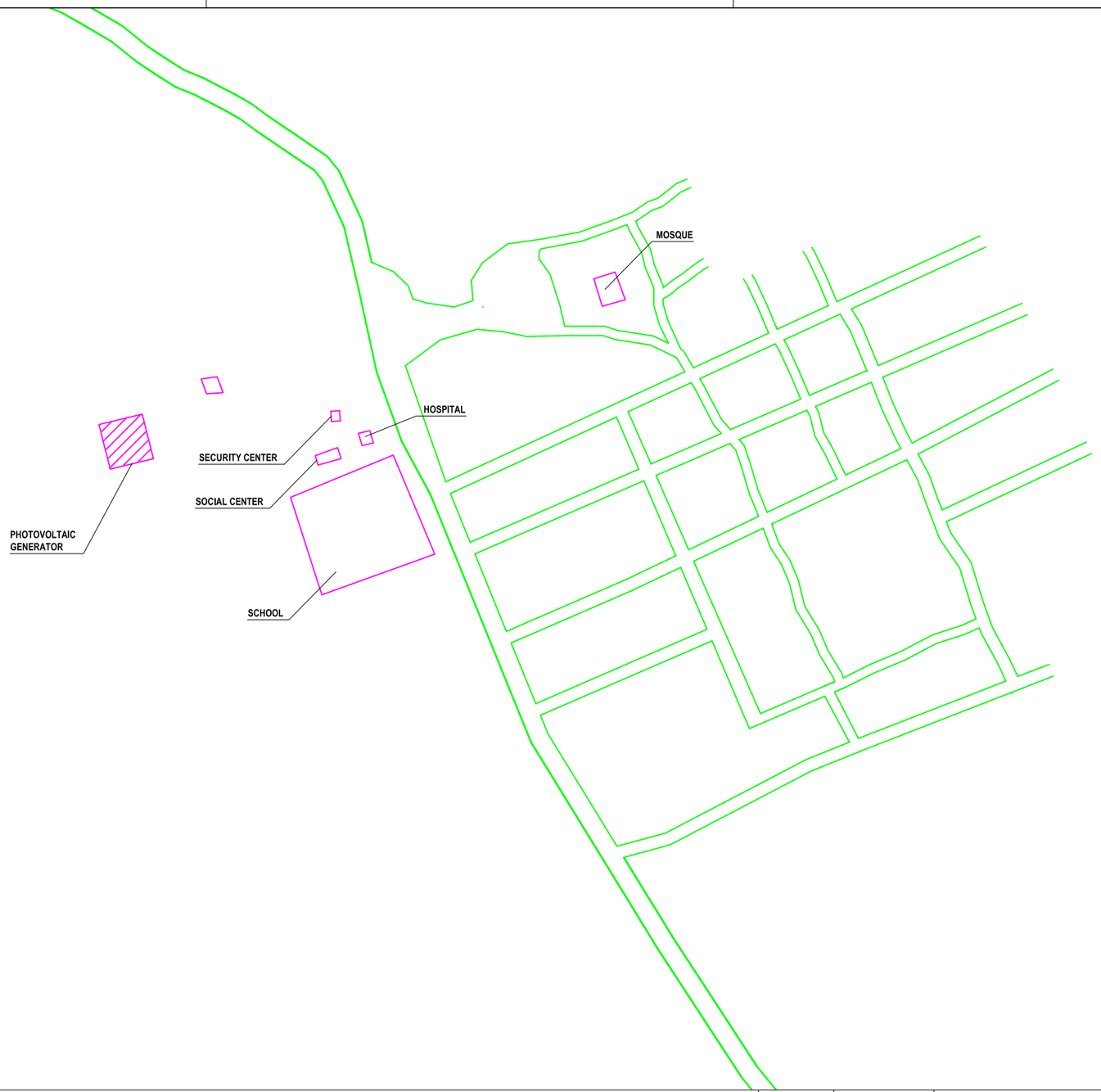
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR LOCATION

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 2.2.1–R00



DOURBALI:
LATITUDE: 11,8º N
LONGITUDE: 15,87º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

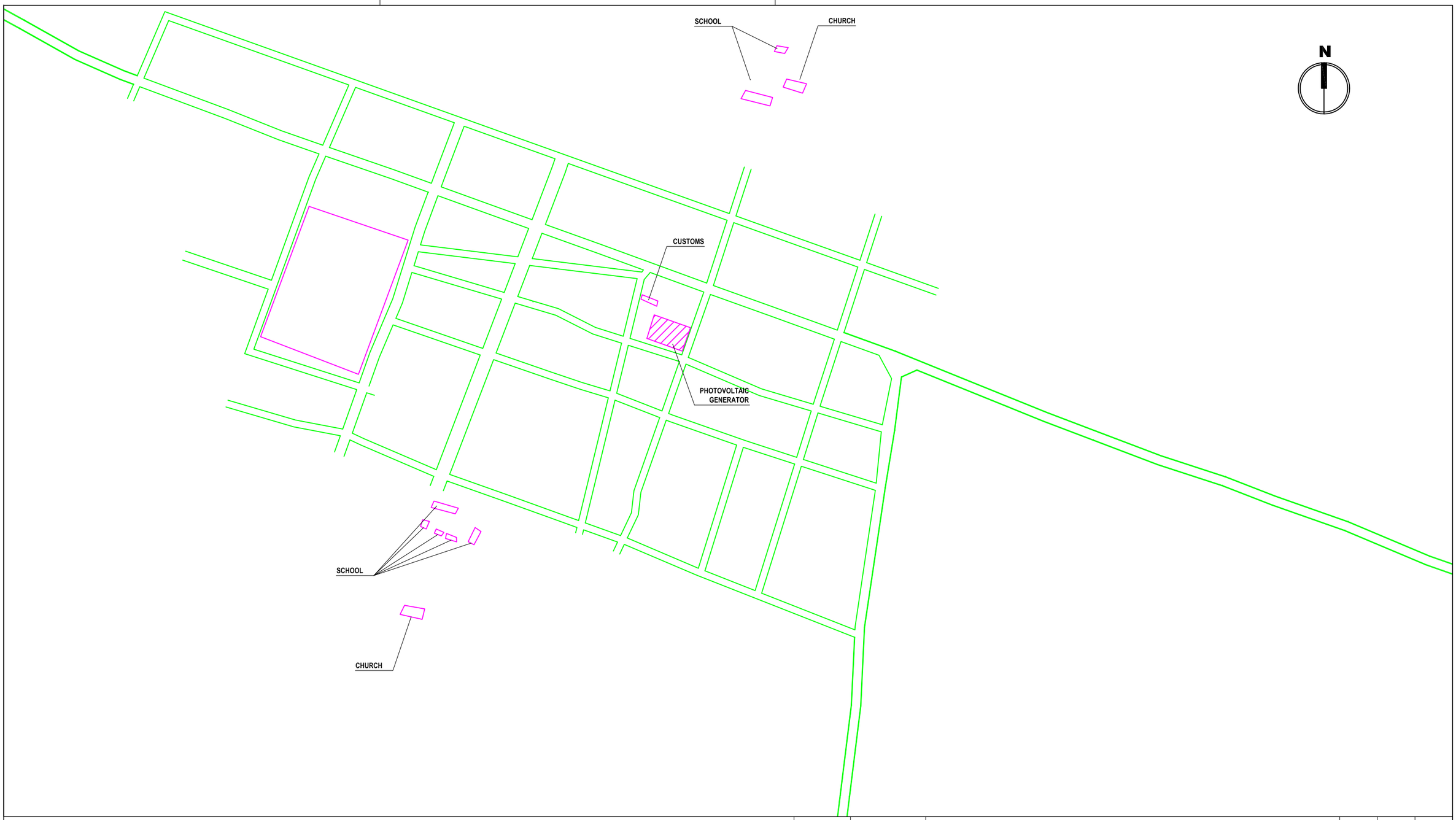
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR LOCATION

DOURBALI

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 2.3.1–R00



GUELENDENG:
LATITUDE: 10,92º N
LONGITUDE: 15,87º E

REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.
R00	28/02/2013		X.R.		

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR LOCATION

GUELENDENG

Promoted:

Approved:

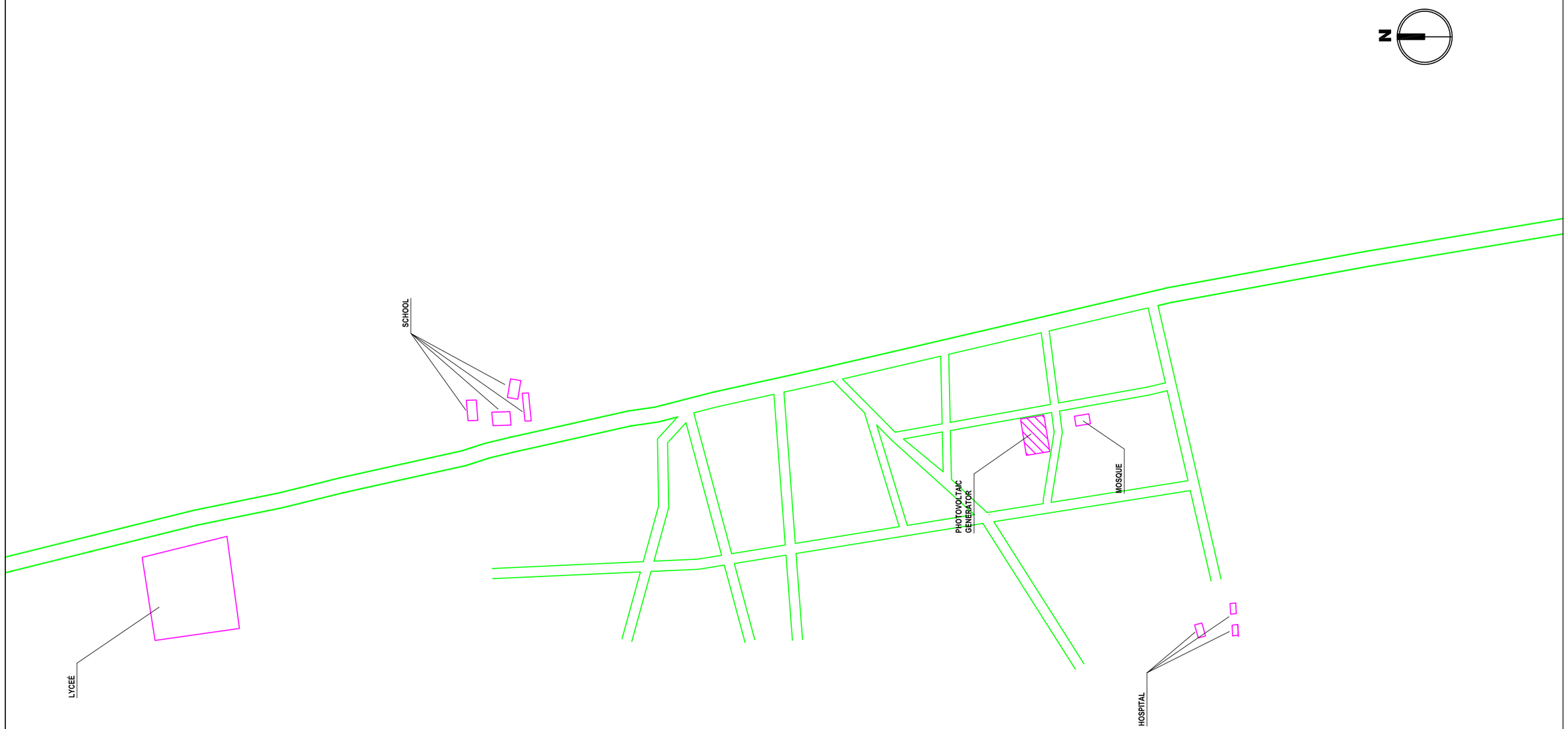
Engineer Xavier Vallvé

Design

www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 2.4.1–R00



MAILAO:
LATITUDE: 11,58º N
LONGITUDE: 15,28º E

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

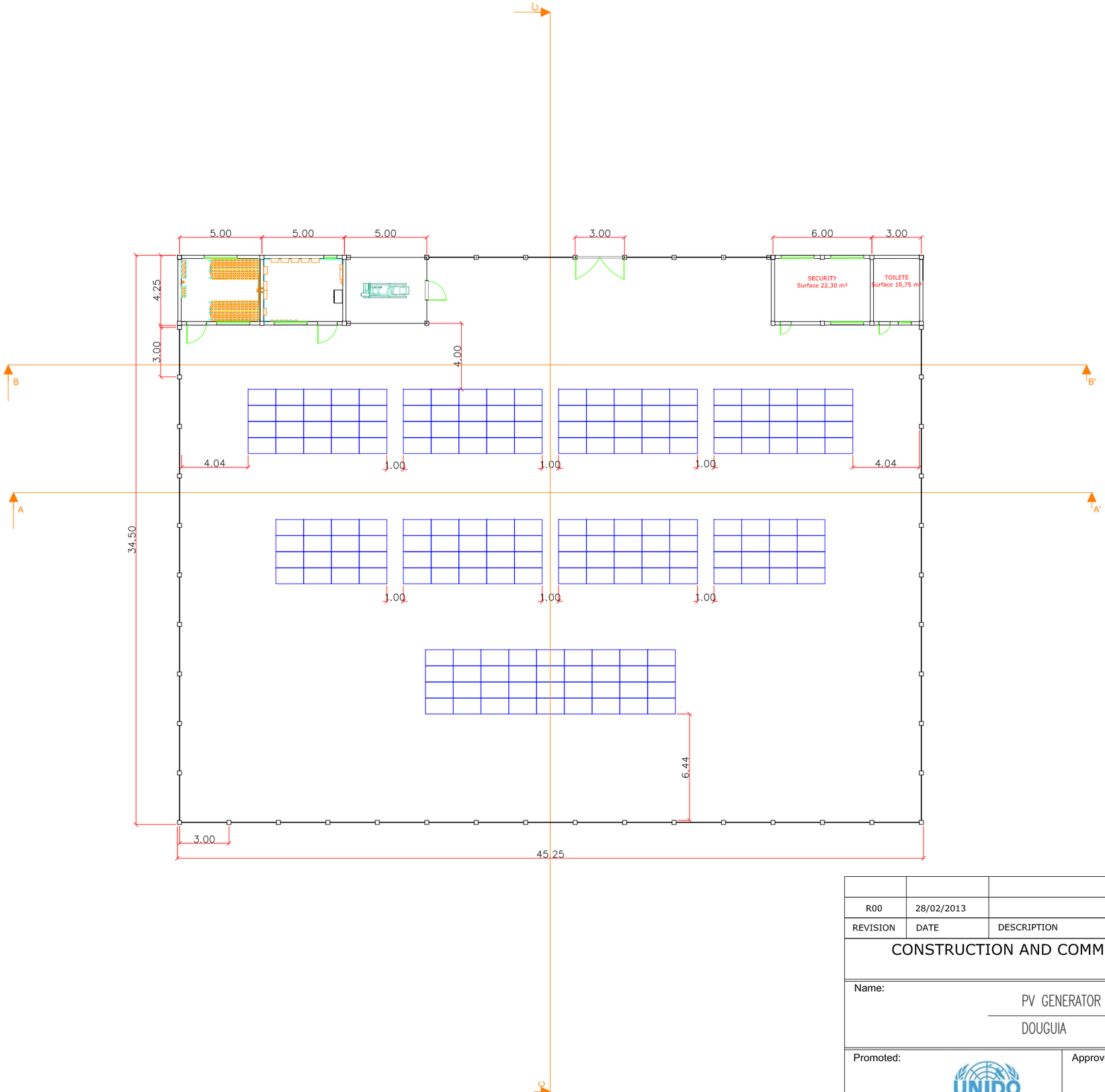
PV GENERATOR LOCATION

MAILAO

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000

Drawing Number:

2.5.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

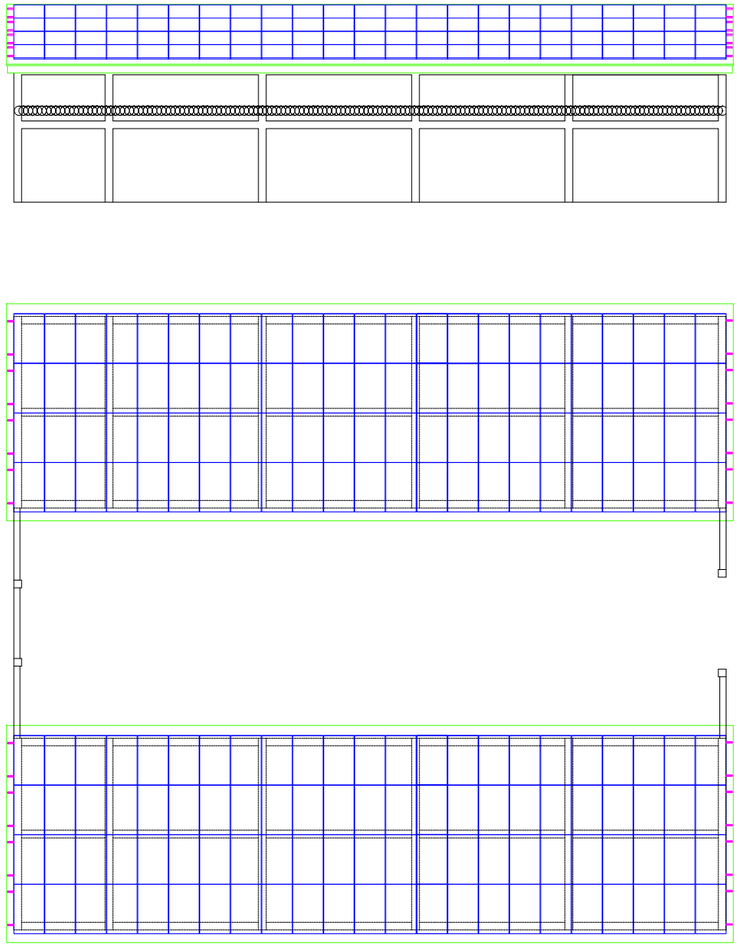
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 1

DOUGUIA

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:250
			Drawing Number: 3.1.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 2

DOUGUIA

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200
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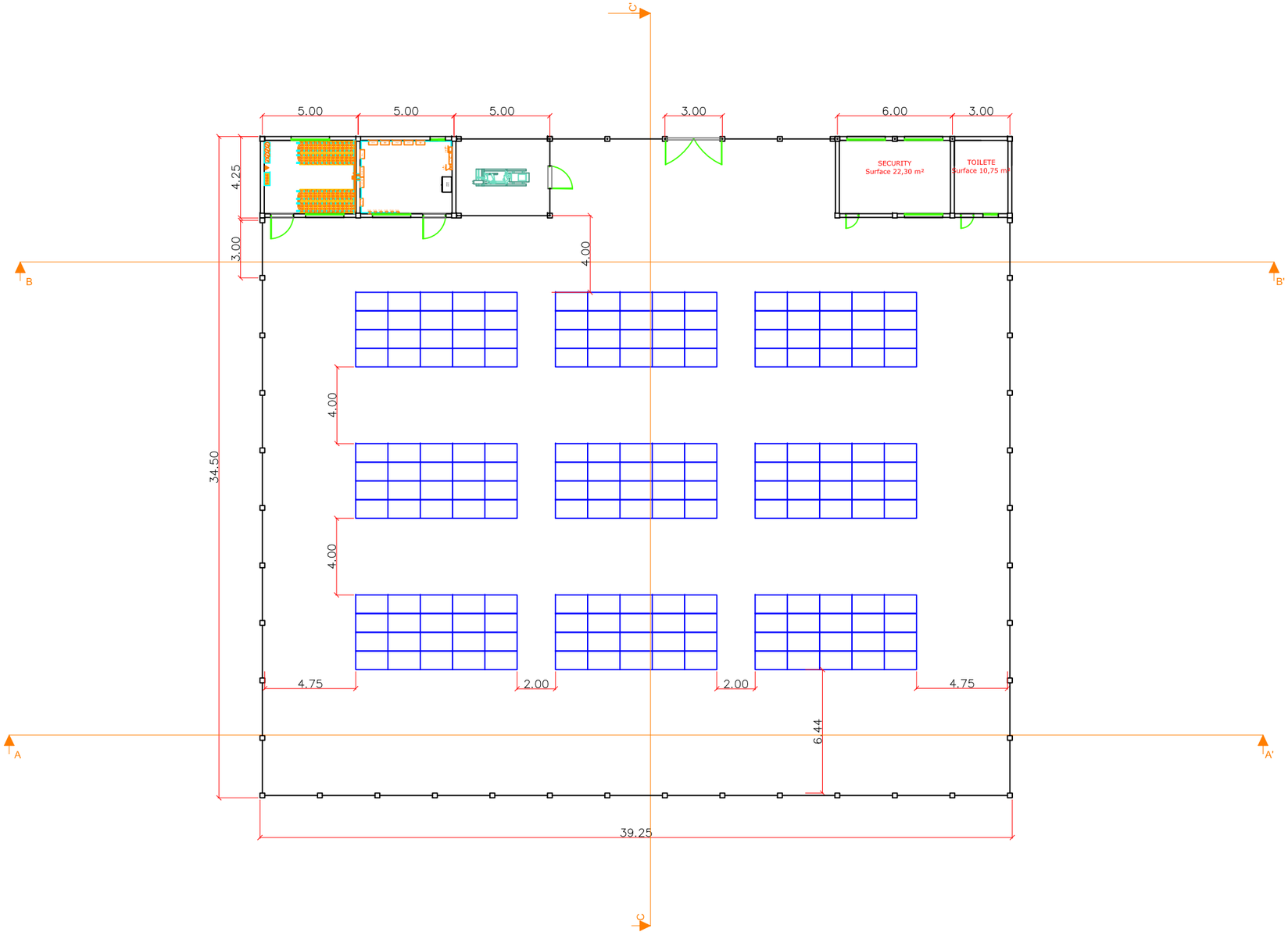


R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

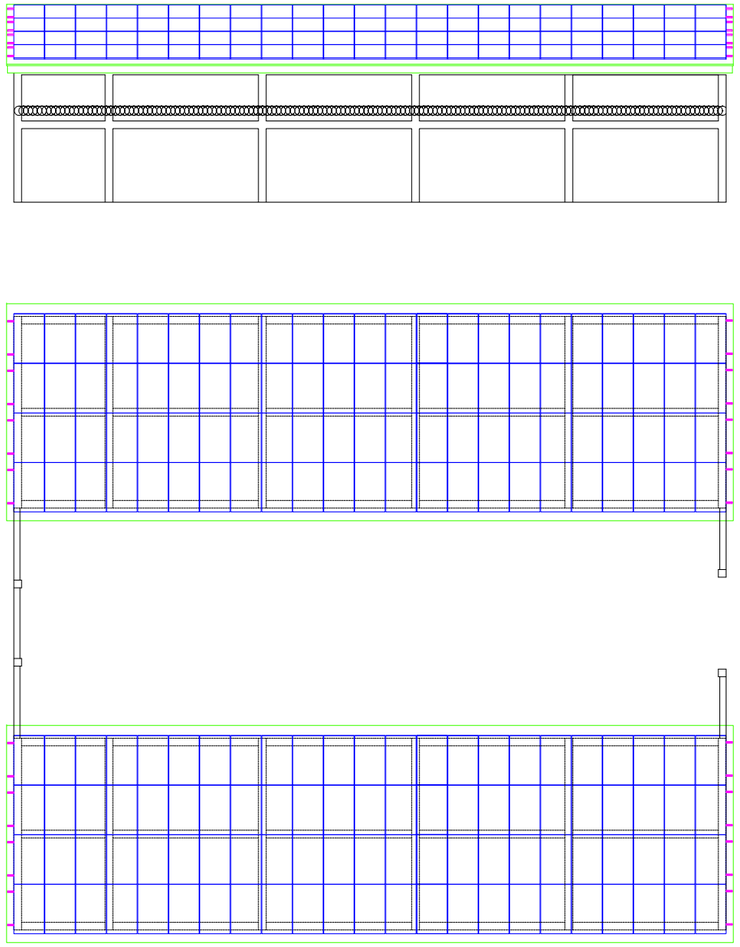
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:250 Drawing Number: 3.2.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 2

MOMBOU

Promoted:

Approved:

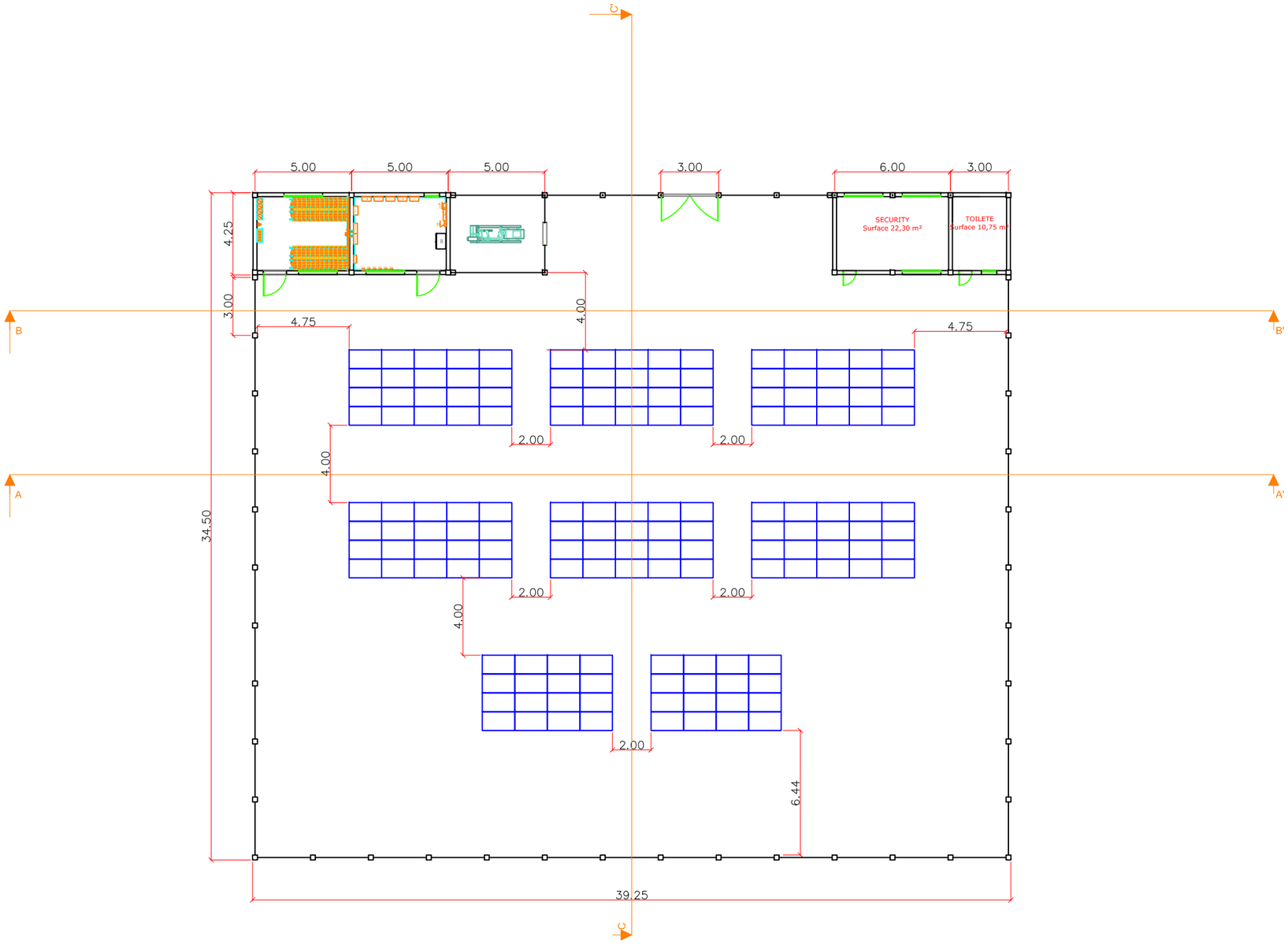
Engineer Xavier Vallvé

Design

www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 3.2.2–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

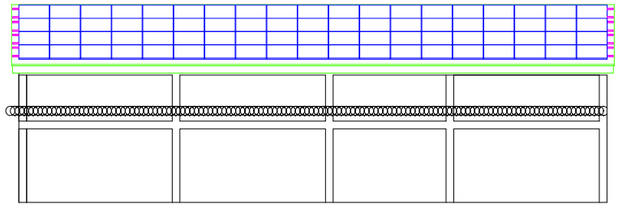
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

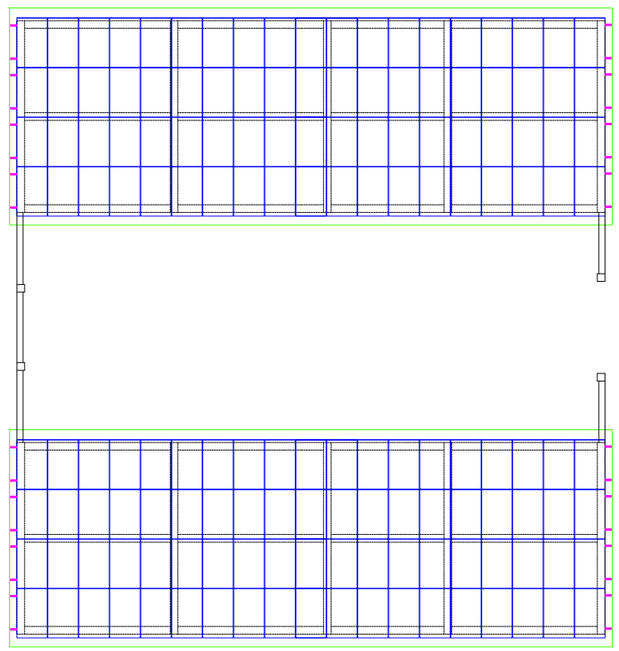
Name:

PV GENERATOR

DOURBALI

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta tramatecnoambiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:250 Drawing Number: 3.3.1–R00





R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

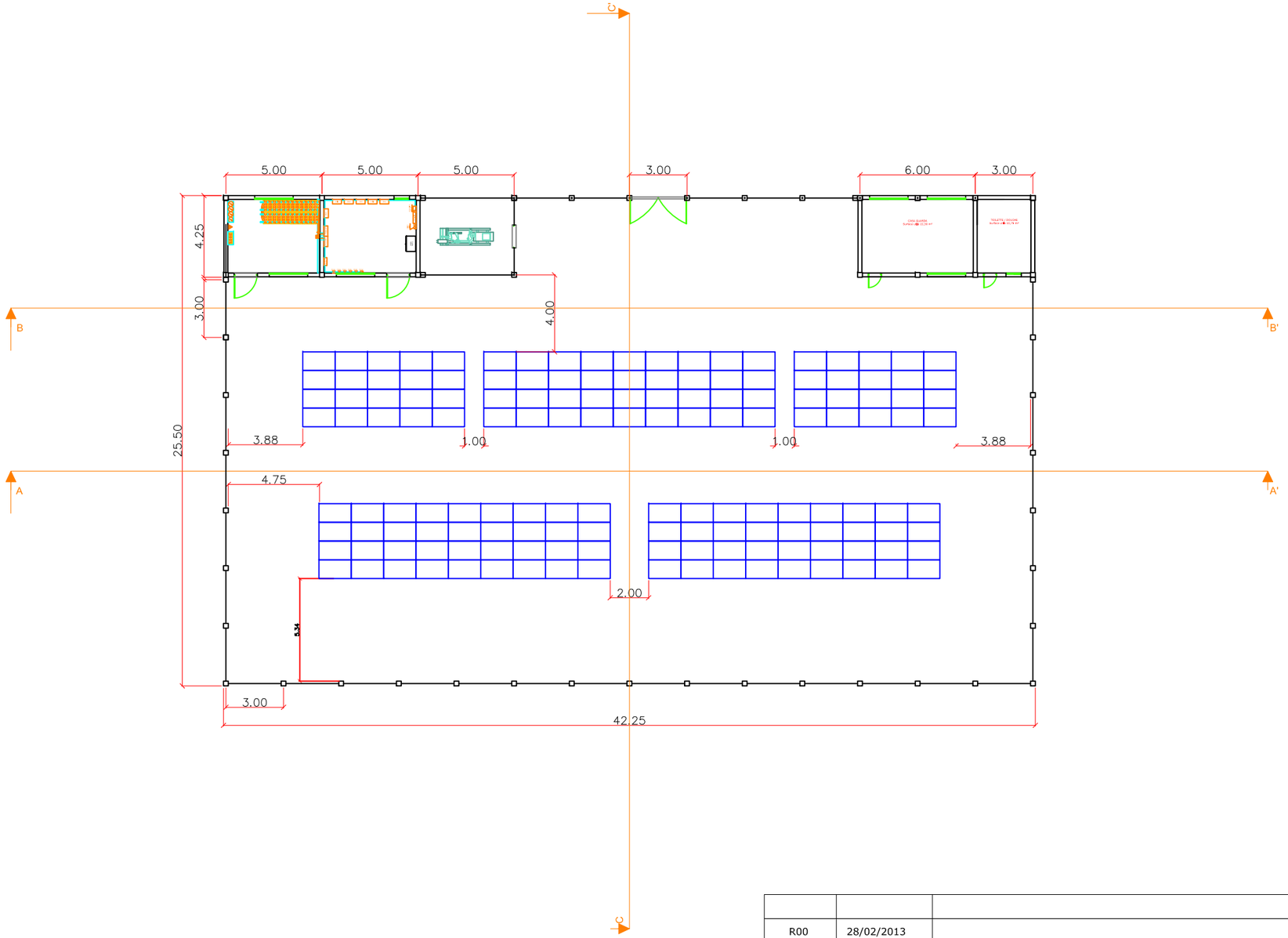
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 2

DOURBALI

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200 Drawing Number: 3.3.2–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

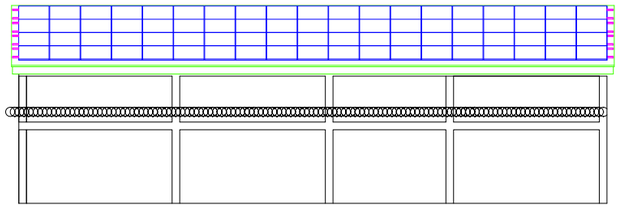
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

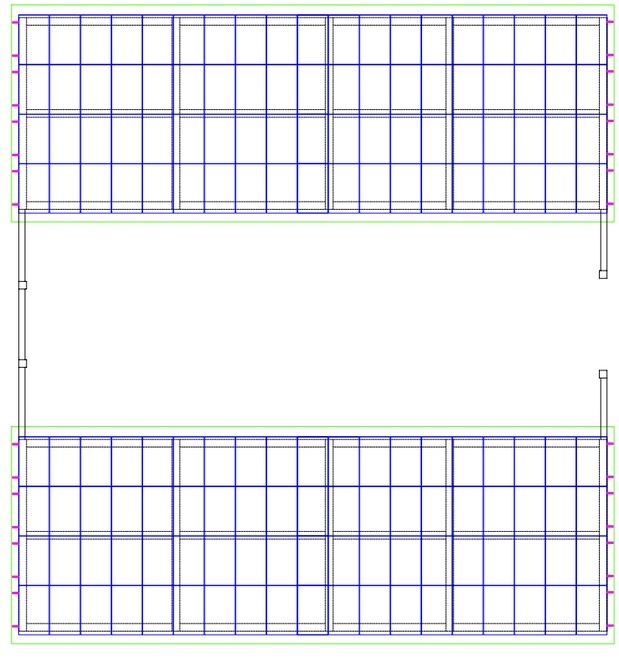
Name:

PV GENERATOR OPTION 1

GUELENDENG

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:250 Drawing Number: 3.4.1–R00





R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

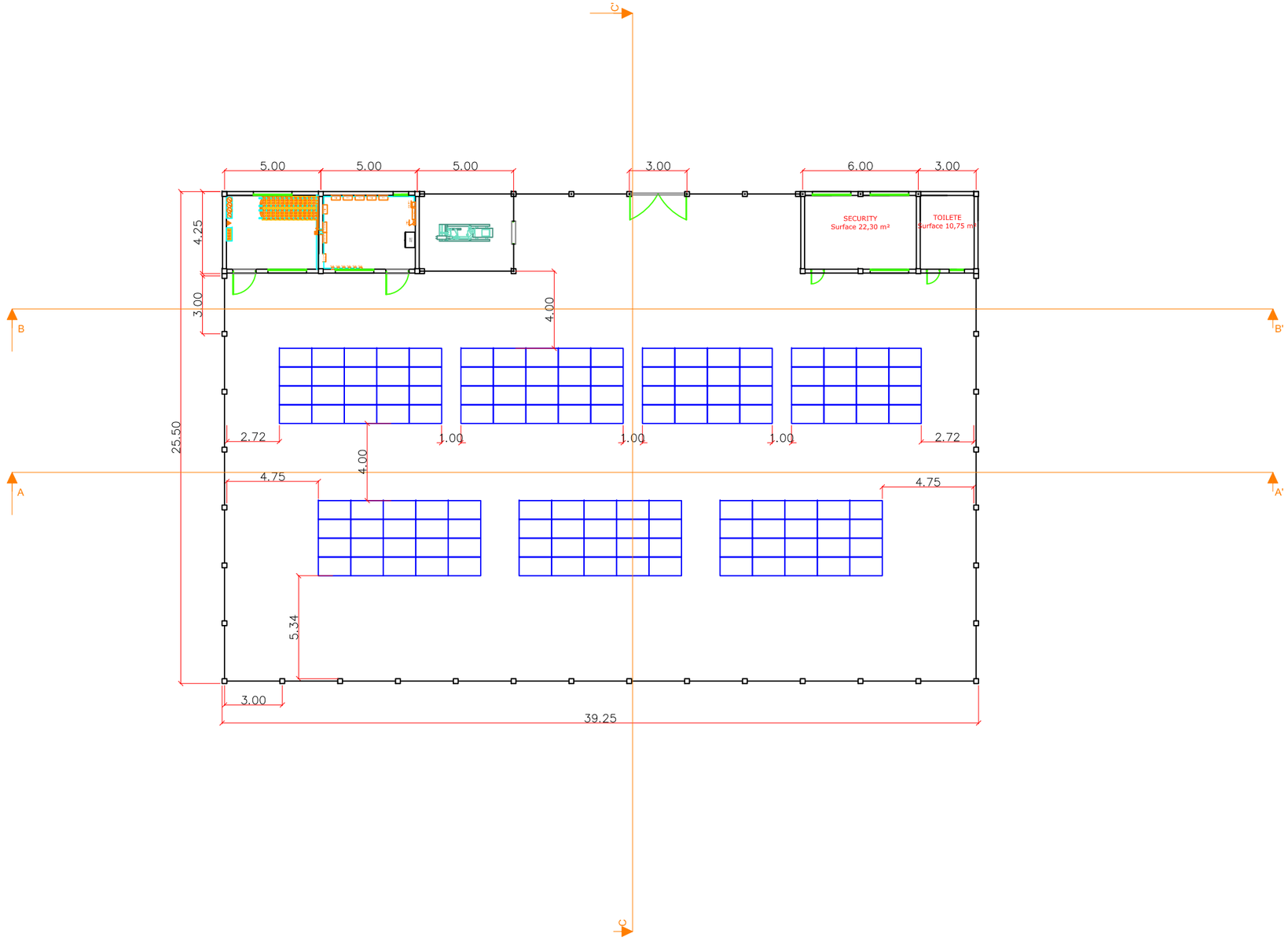
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 2

GUELENDENG

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200 Drawing Number: 3.4.2–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

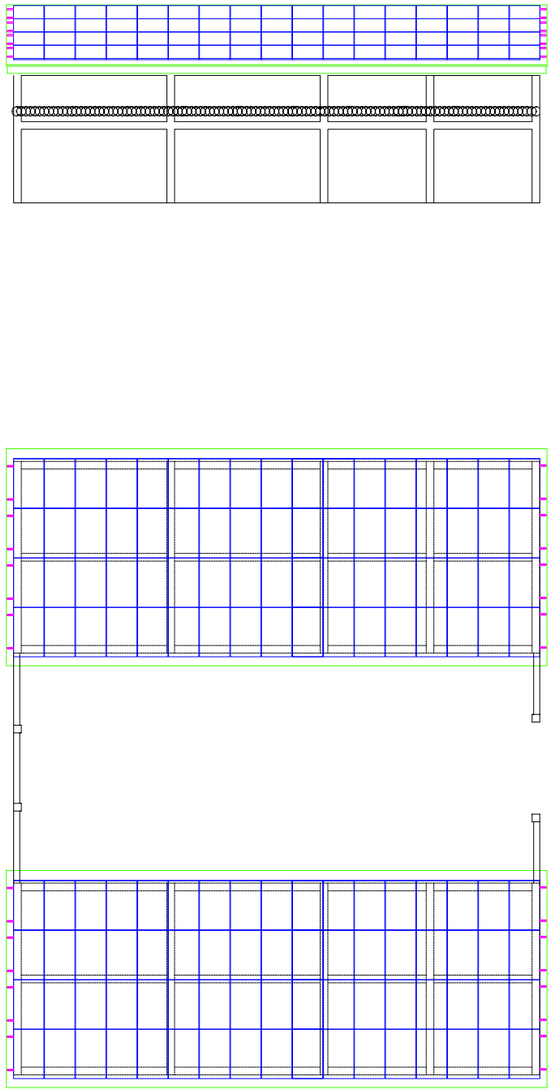
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 1

MAILAO

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:250 Drawing Number: 3.5.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

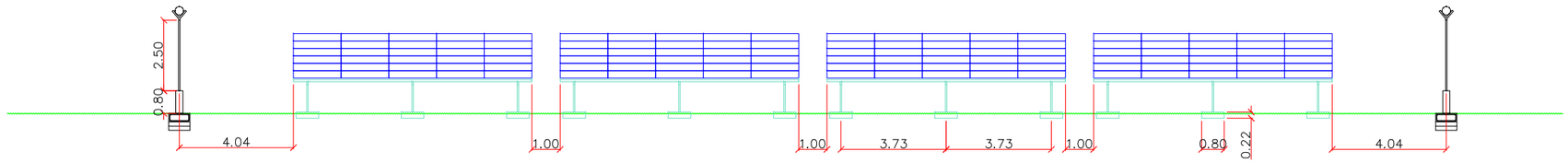
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

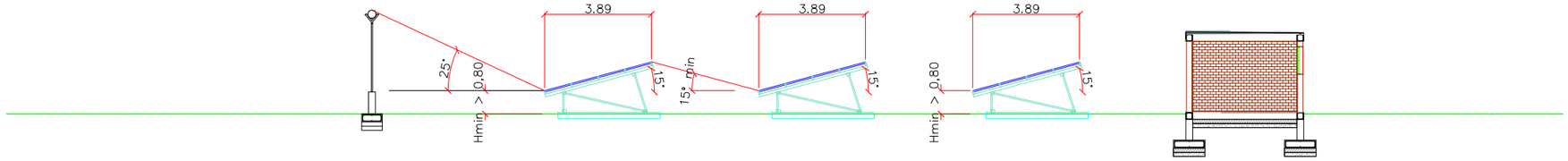
PV GENERATOR OPTION 2

MAILAO

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200
			Drawing Number: 3.5.2–R00



SECTION A-A'



SECTION C-C'

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR DETAILS OPTION 1

DOUGUIA

Promoted:

Approved:

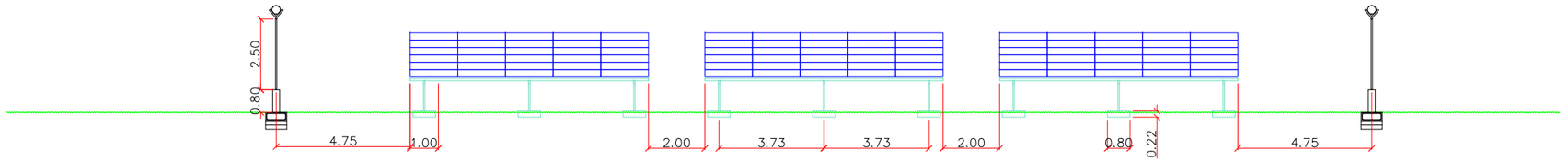
Engineer Xavier Vallvé

Design

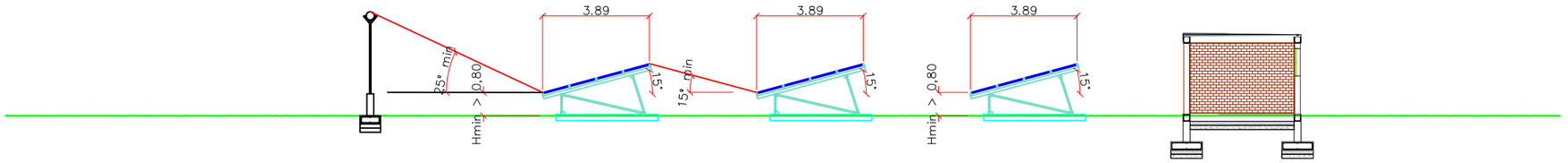
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 4.1.1–R00



SECTION A-A'



SECTION C-C'

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR DETAILS

MOMBOU

Promoted:

Approved:

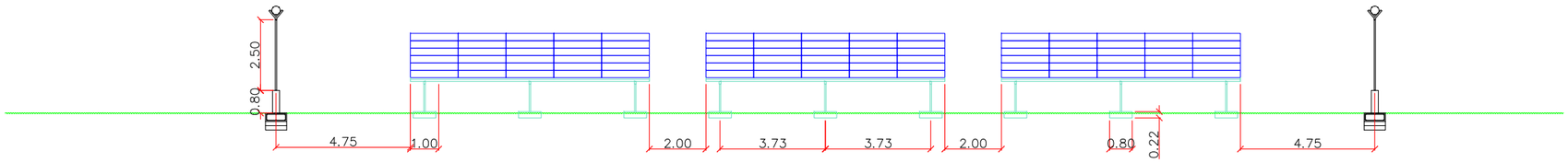
Engineer Xavier Vallvé

Design

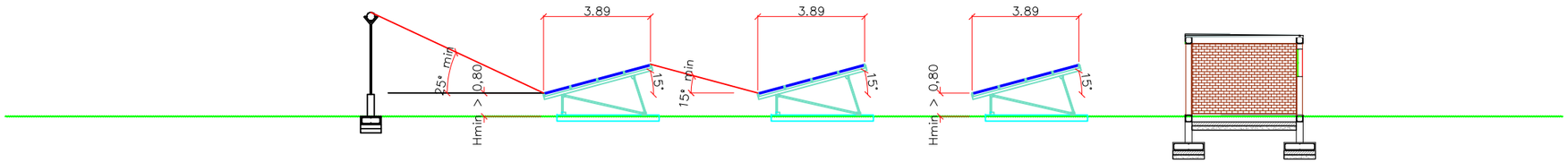
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 4.2.1–R00



SECTION A-A'



SECTION C-C'

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

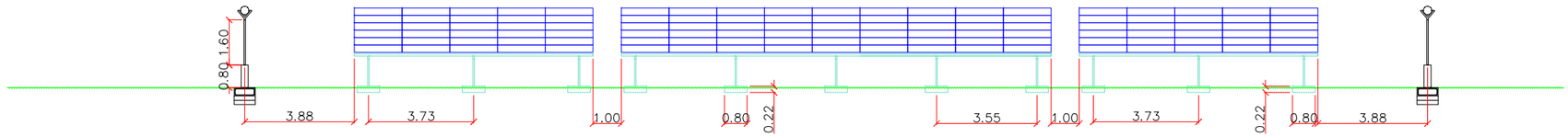
PV GENERATOR DETAILS

DOURBALI

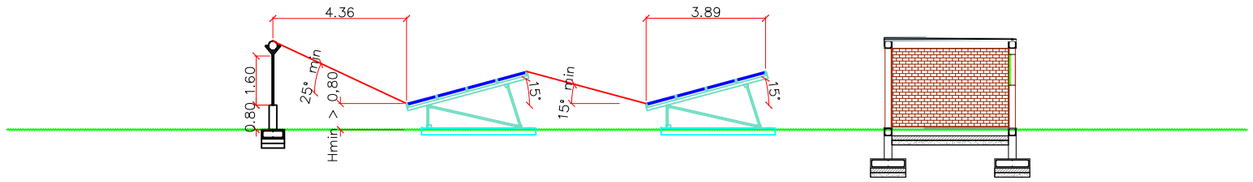
Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200

Drawing Number:

4.3.1–R00



SECTION A-A'



SECTION C-C'

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 1 DETAILS

GUELENDENG

Promoted: UNIDO

Approved:

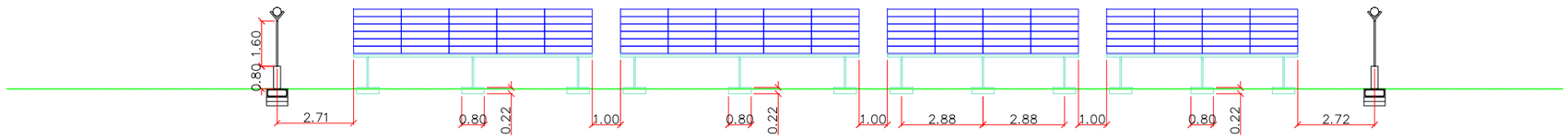
Engineer Xavier Vallvé

Design

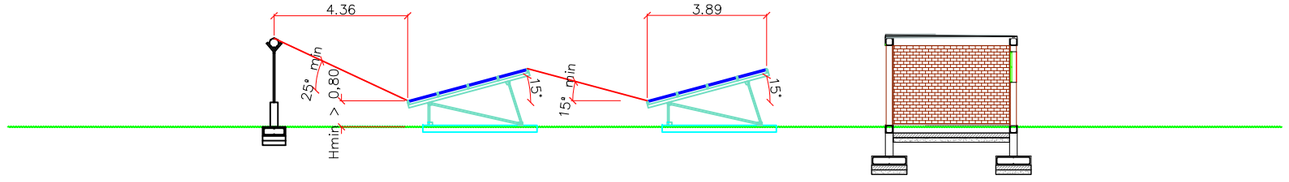
tta Trama TecnoAmbiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 4.4.1–R00



SECTION A-A'



SECTION C-C'

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR OPTION 1 DETAILS

MAILAO

Promoted:

Approved:

Engineer Xavier Vallvé

Design

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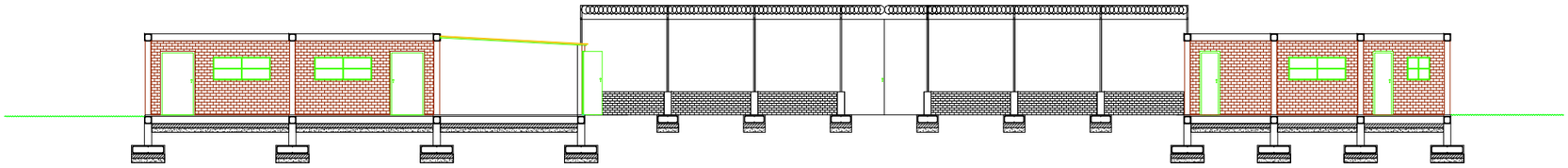
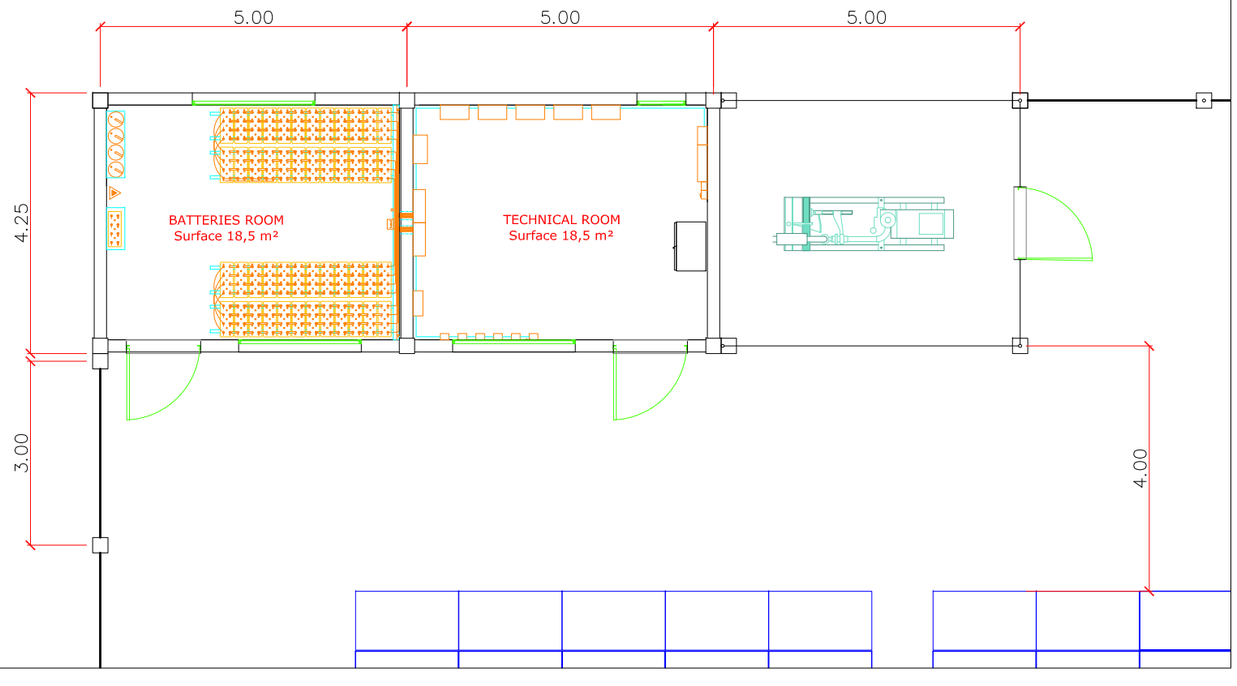
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 4.5.1–R00



SECTION B-B'
ESC 1:200



TECHNICAL ROOM
ESC 1:100

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

TECHNICAL ROOMS OPTION 1

DOUGUIA

Promoted: UNIDO

Approved:

Engineer Xavier Vallvé

Design

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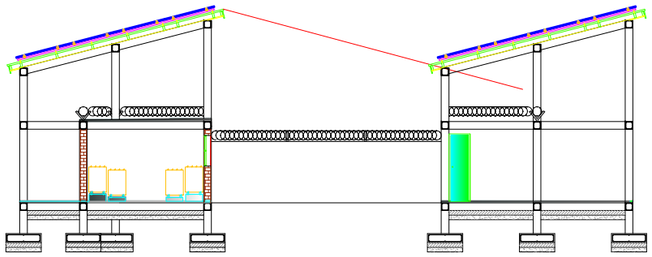
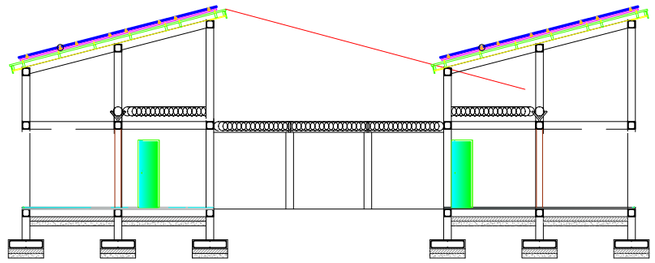
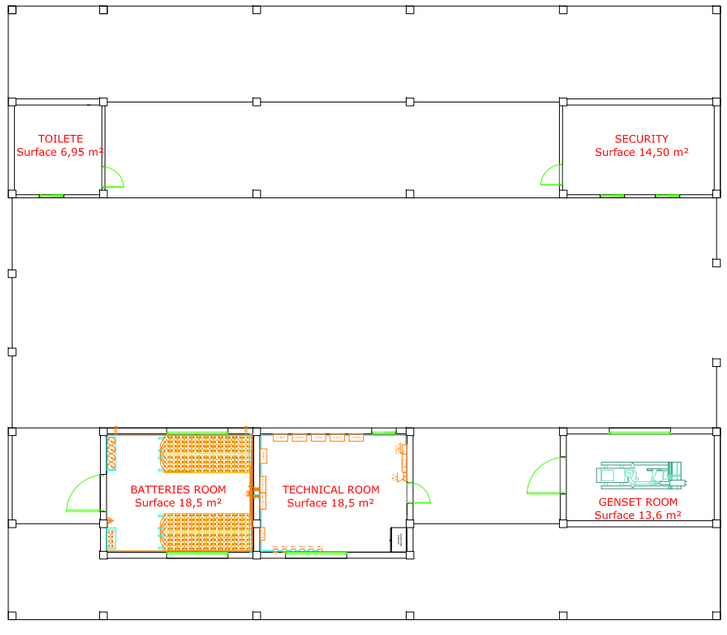
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: VAR

Drawing Number: 5.1.1–R00







R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

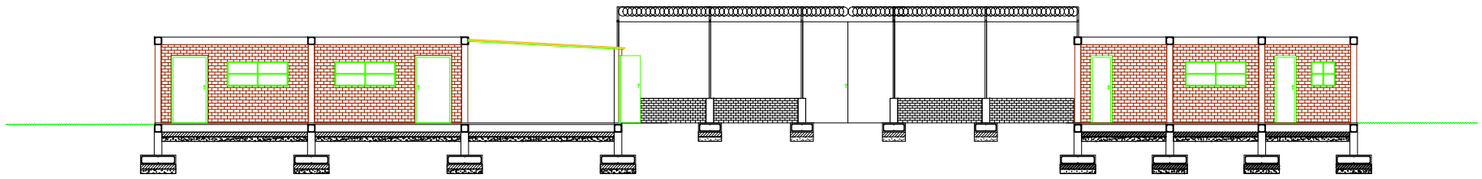
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

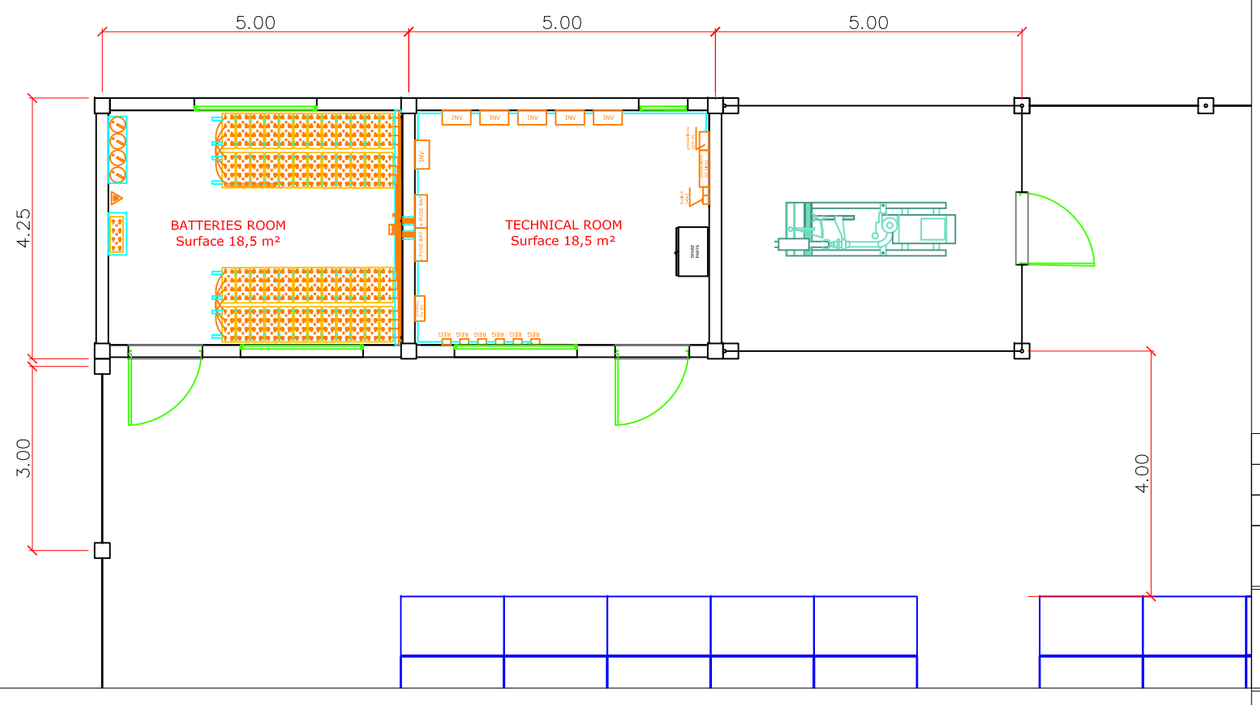
TECHNICAL ROOMS OPTION 2

DOUGUIA

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200 Drawing Number: 5.1.2–R00



SECTION B-B'
ESC 1:200



TECHNICAL ROOM
ESC 1:100

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:
TECHNICAL ROOMS
MOMBOU

Promoted:

Approved:
Engineer Xavier Vallvé

Design
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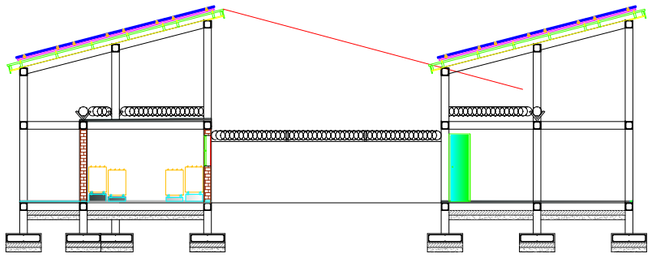
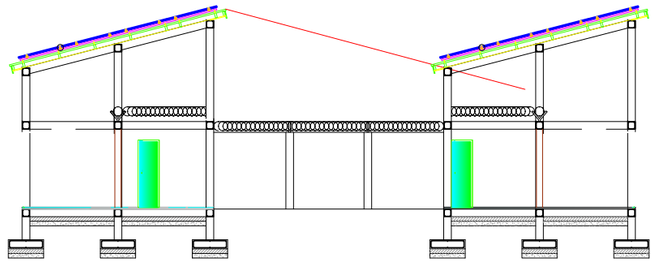
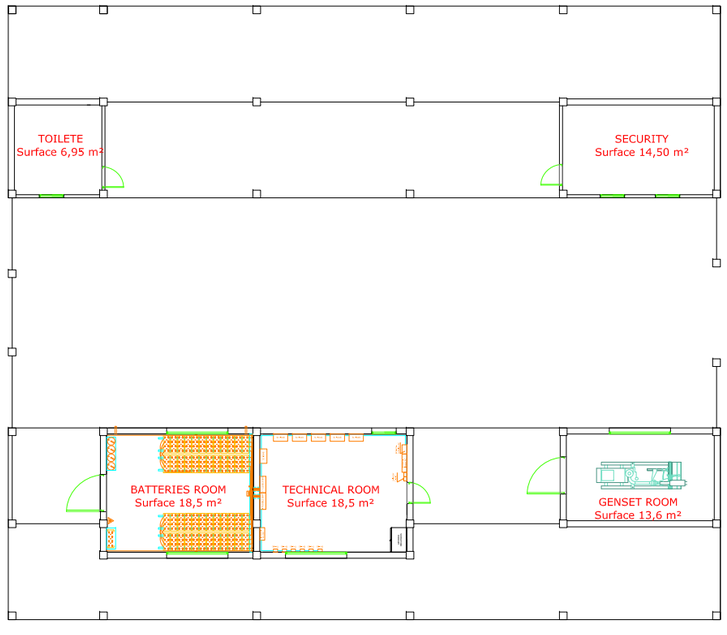
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale:
VAR

Drawing Number:
5.2.1–R00







R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

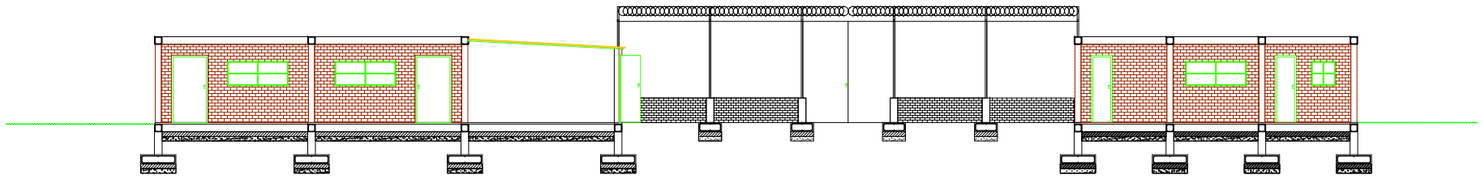
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

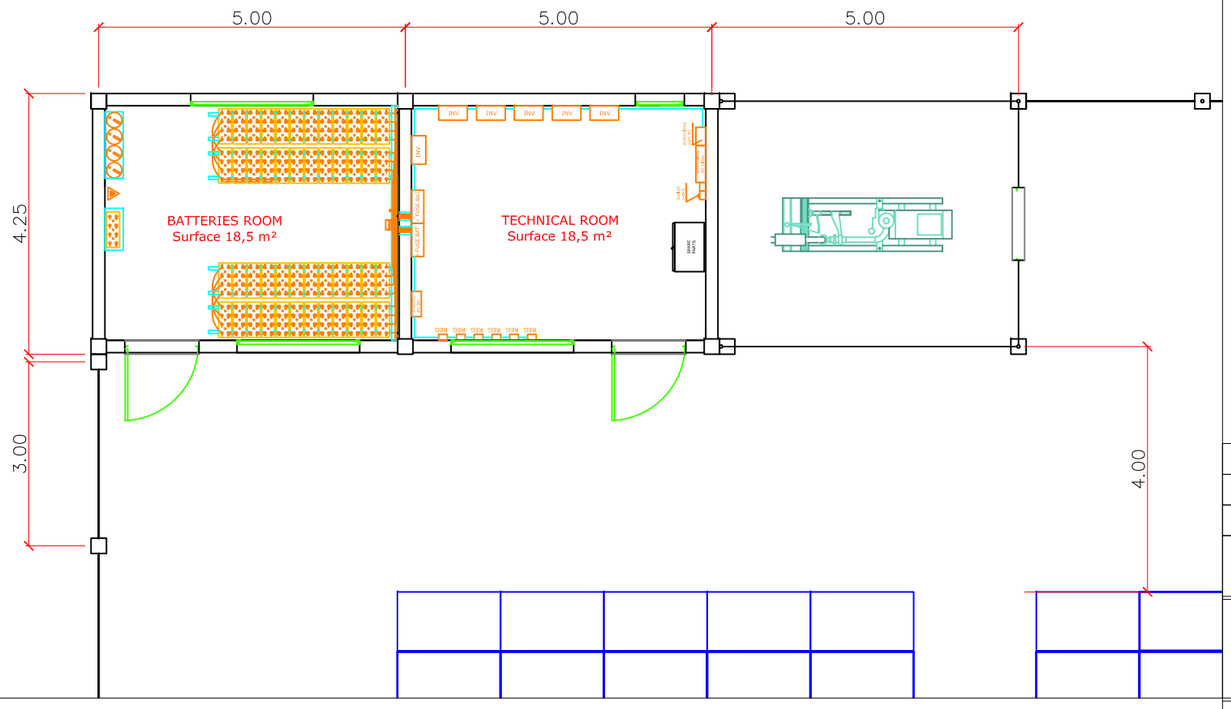
TECHNICAL ROOMS OPTION 2

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200 Drawing Number: 5.2.2–R00



SECTION B-B'
ESC 1:200



TECHNICAL ROOM
ESC 1:100

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

TECHNICAL ROOMS

DOURBALI

Promoted:

Approved:

Engineer Xavier Vallvé

Design

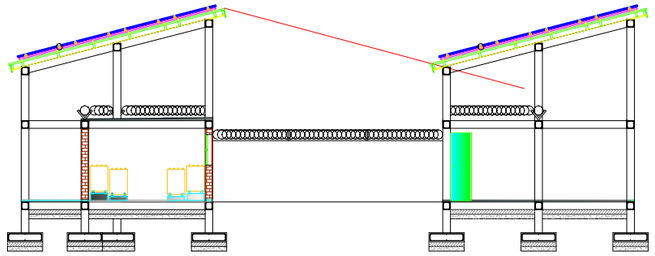
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

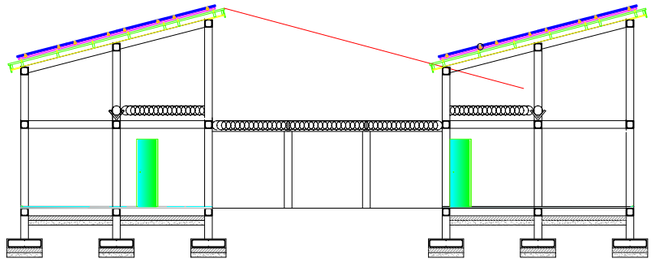
Escale:

VAR

Drawing Number:

5.3.1–R00





R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

TECHNICAL ROOMS OPTION 2

DOURBALI

Promoted:

Approved:

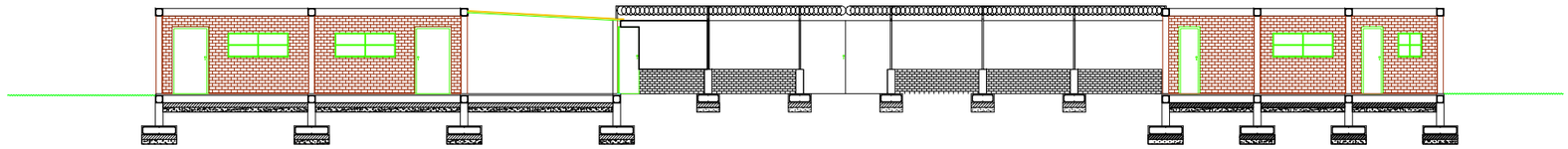
Engineer Xavier Vallvé

Design

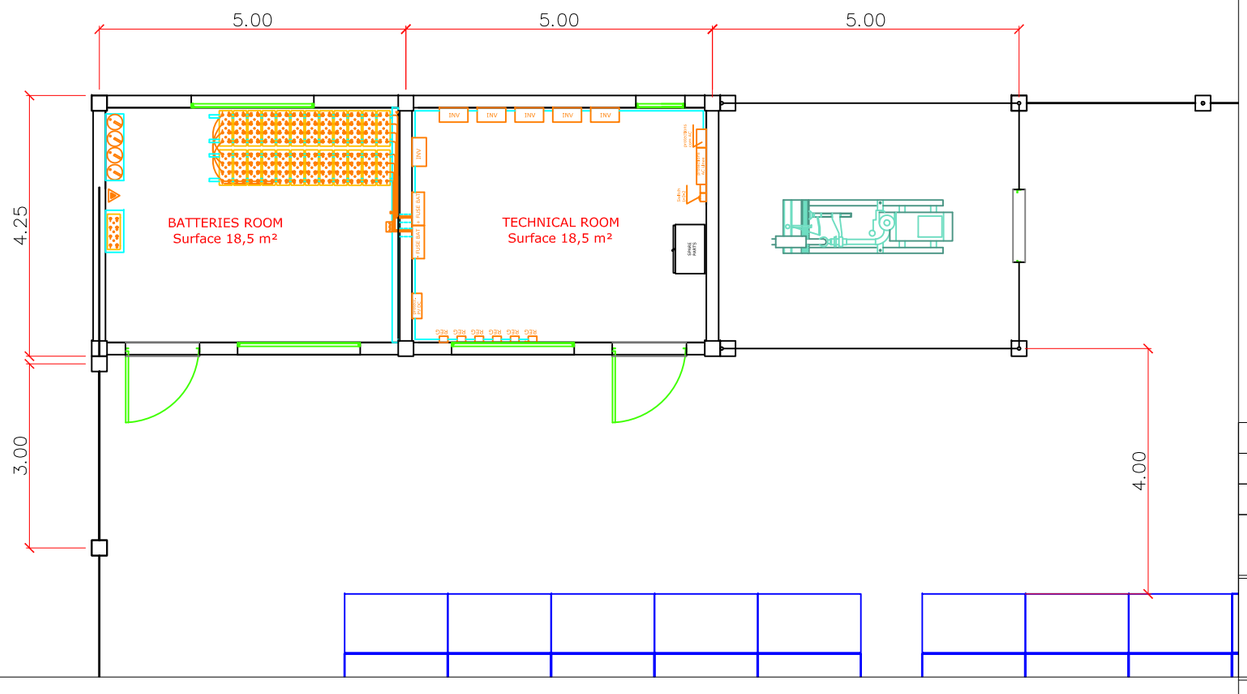
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 5.3.2–R00



SECTION B-B'
ESC 1:200



TECHNICAL ROOM
ESC 1:100

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

TECHNICAL ROOMS OPTION 1

GUELENDENG

Promoted:

Approved:

Engineer Xavier Vallvé

Design

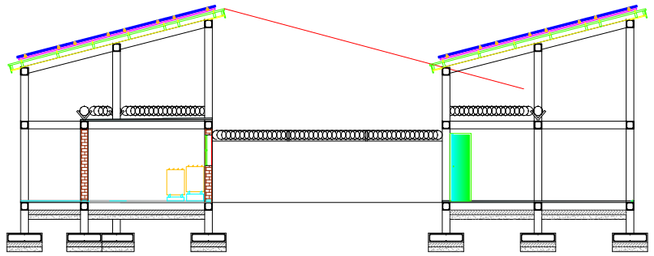
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

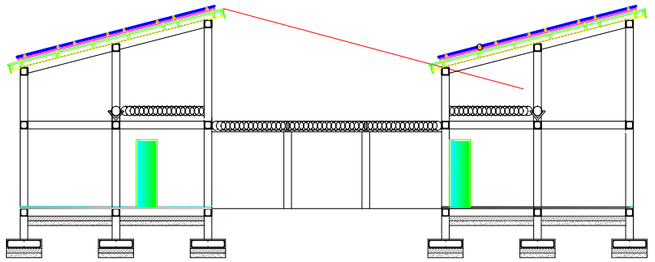
Escale:

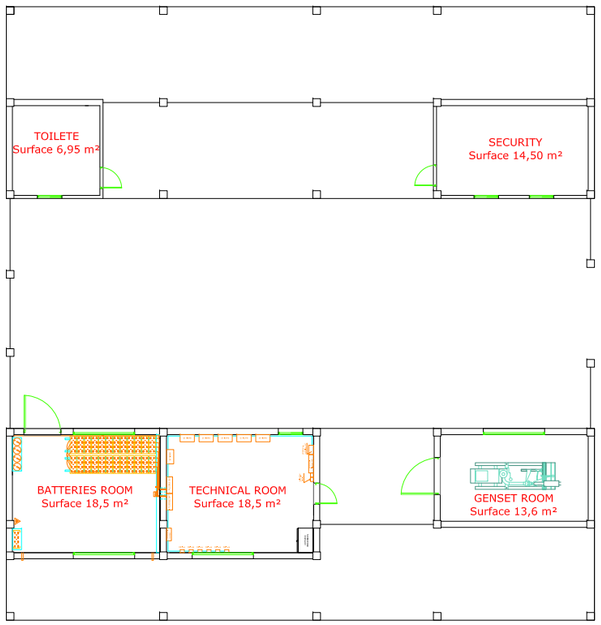
VAR

Drawing Number:

5.4.1–R00







R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

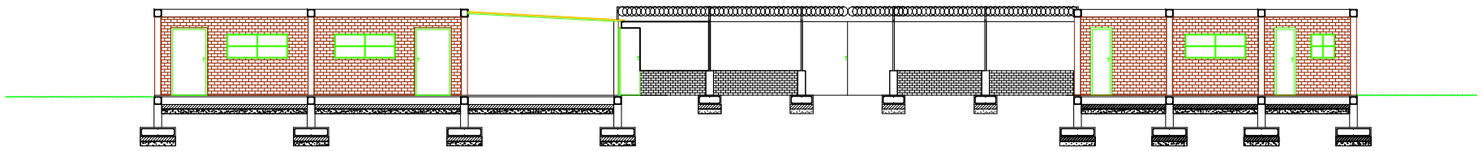
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

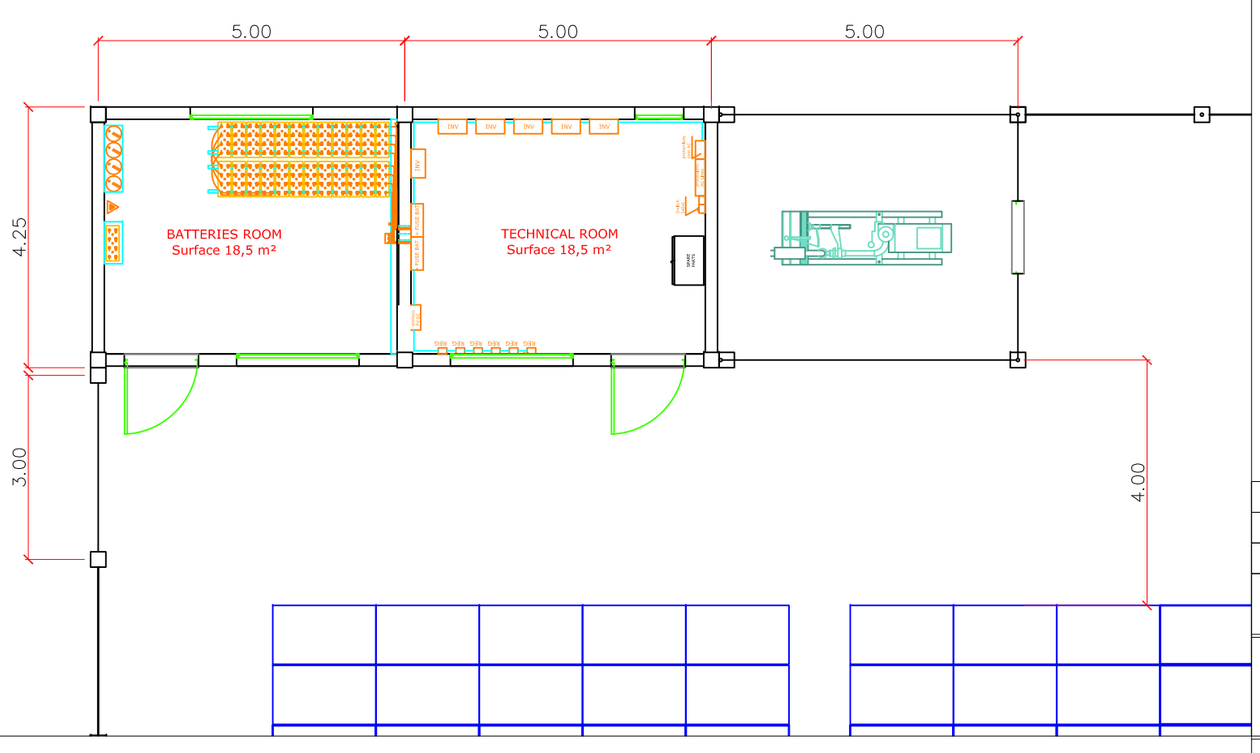
TECHNICAL ROOMS OPTION 2

GUELENDENG

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama Tecnoambiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:200 Drawing Number: 5.4.2–R00



SECTION B-B'
ESC 1:200



TECHNICAL ROOM
ESC 1:100

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

TECHNICAL ROOMS OPTION 1

MAILAO

Promoted:

Approved:

Engineer Xavier Vallvé

Design

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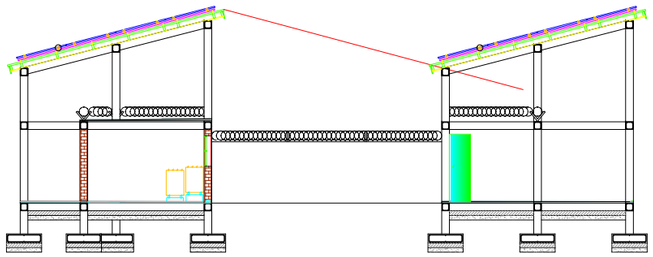
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

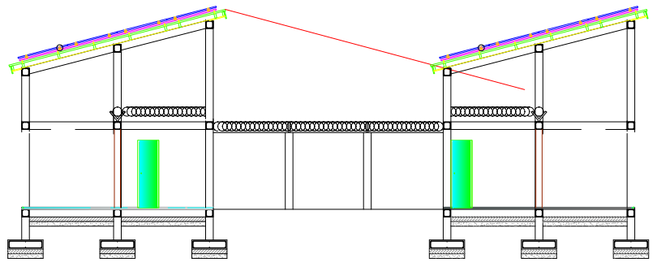
Escale:

VAR

Drawing Number:

5.5.1–R00





R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

TECHNICAL ROOMS OPTION 2

MAILAO

Promoted:

Approved:

Engineer Xavier Vallvé

Design

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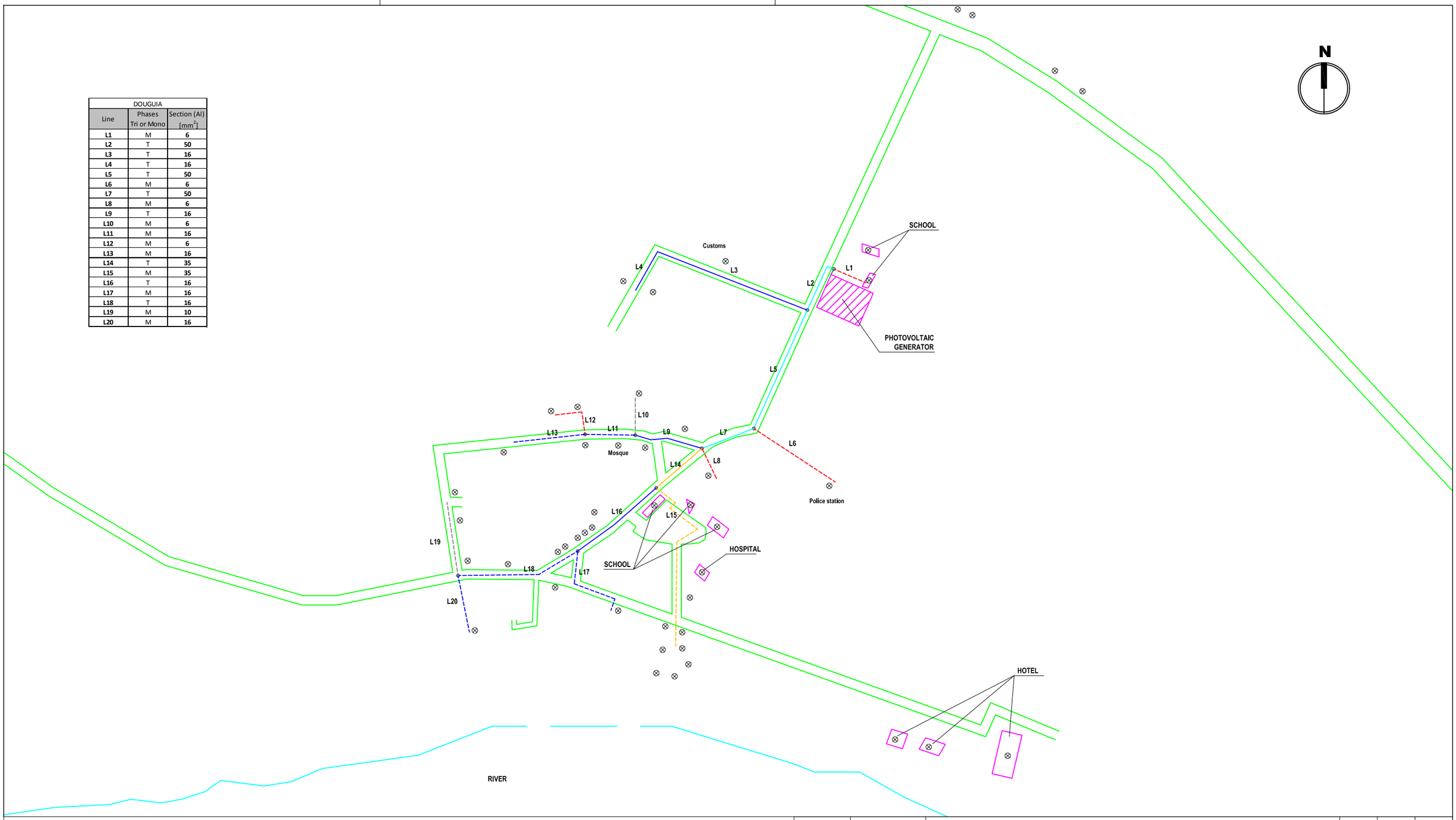
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:200

Drawing Number: 5.5.2–R00

DOUGUIA		
Line	Phases Tri or Mono	Section (Al) [mm^2]
L1	M	**6**
L2	T	**50**
L3	T	**16**
L4	T	**16**
L5	T	**50**
L6	M	**6**
L7	T	**50**
L8	M	**6**
L9	T	**16**
L10	M	**6**
L11	M	**16**
L12	M	**6**
L13	M	**16**
L14	T	**35**
L15	M	**35**
L16	T	**16**
L17	M	**16**
L18	T	**16**
L19	M	**10**
L20	M	**16**



LEGEND:

⊗ POTENTIAL USERS VISITED

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name: ELECTRIC DISTRIBUTION GRID

DOUGUIA

Promoted: UNIDO

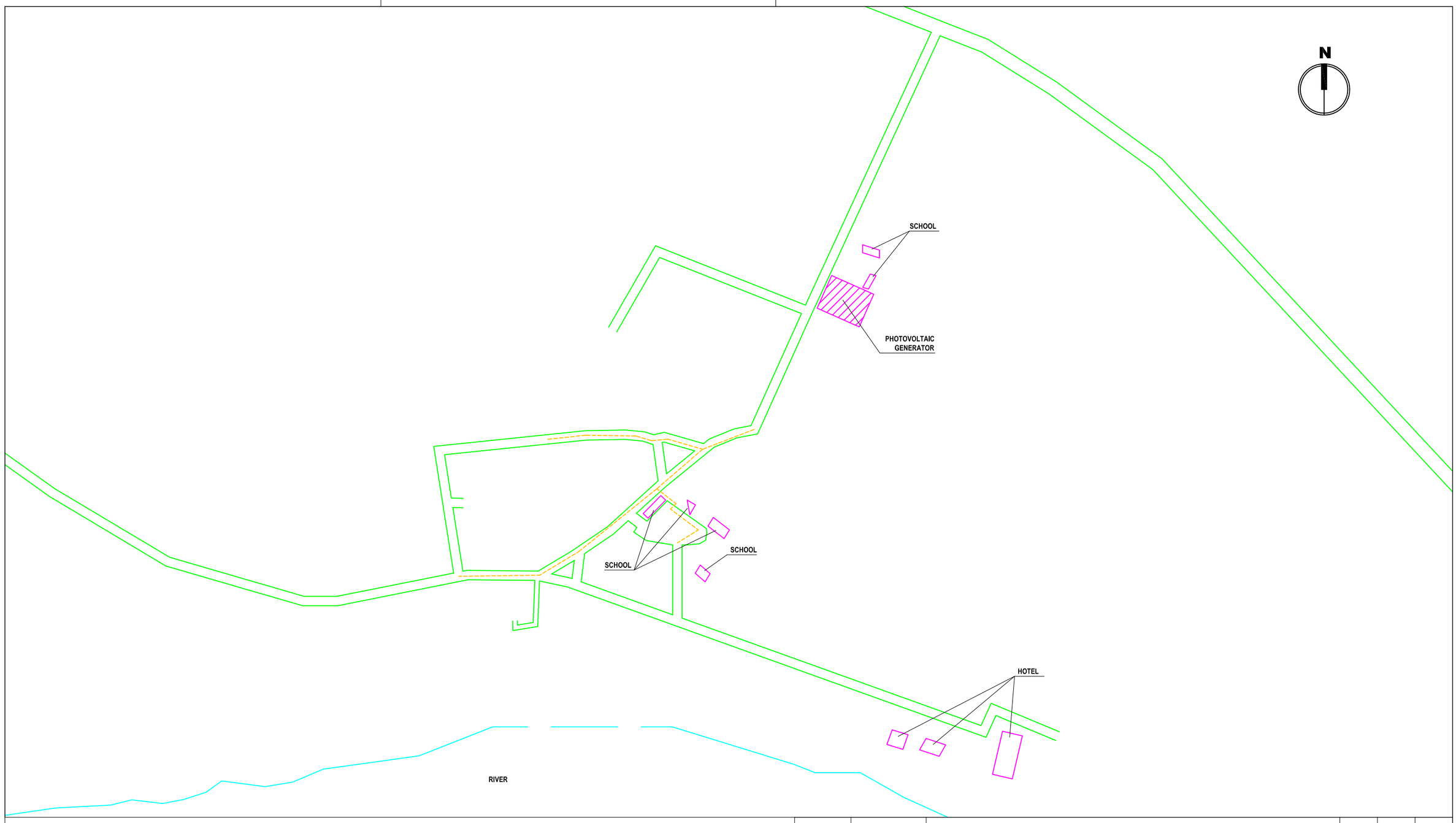
Approved: Engineer Xavier Vallvé

Design: tta Trama TecnoAmbiental

www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 6.1.1–R00



LEGEND:
PUBLIC LIGHTING LINE

REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.
R00	28/02/2013		X.R.		

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

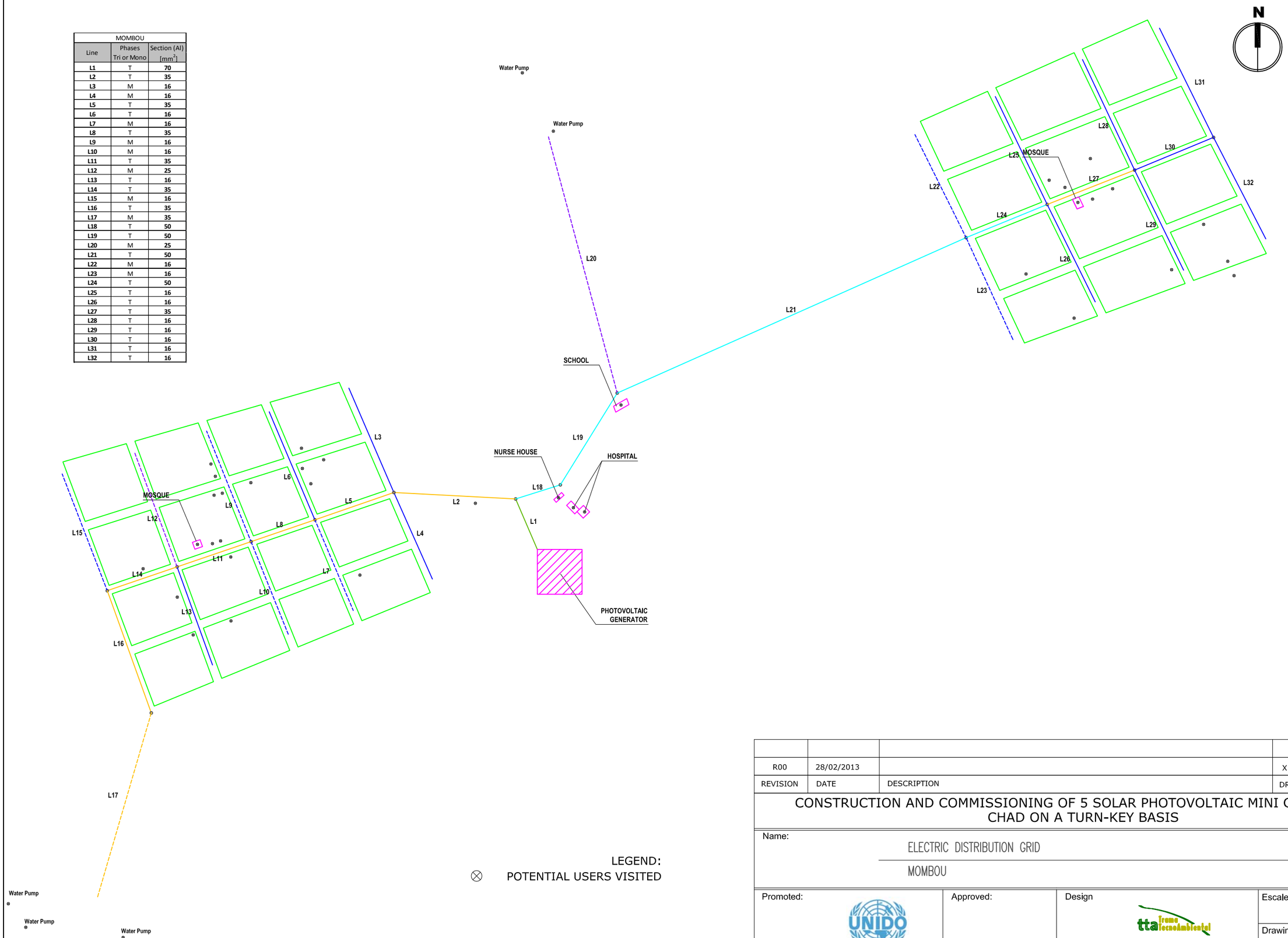
Name:

PUBLIC LIGHTING GRID

DOUGUIA

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 6.1.2–R00

MOMBOU		
Line	Phases Tri or Mono	Section (Al) [mm^2]
L1	T	**70**
L2	T	**35**
L3	M	**16**
L4	M	**16**
L5	T	**35**
L6	T	**16**
L7	M	**16**
L8	T	**35**
L9	M	**16**
L10	M	**16**
L11	T	**35**
L12	M	**25**
L13	T	**16**
L14	T	**35**
L15	M	**16**
L16	T	**35**
L17	M	**35**
L18	T	**50**
L19	T	**50**
L20	M	**25**
L21	T	**50**
L22	M	**16**
L23	M	**16**
L24	T	**50**
L25	T	**16**
L26	T	**16**
L27	T	**35**
L28	T	**16**
L29	T	**16**
L30	T	**16**
L31	T	**16**
L32	T	**16**



LEGEND:

⊗ POTENTIAL USERS VISITED

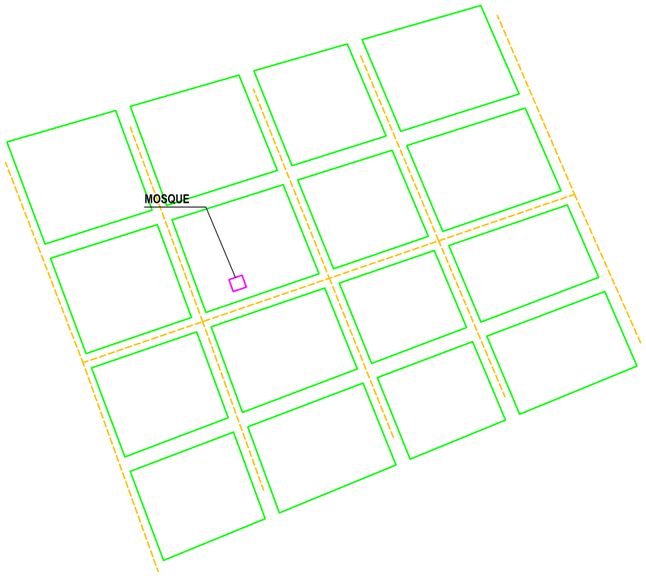
R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

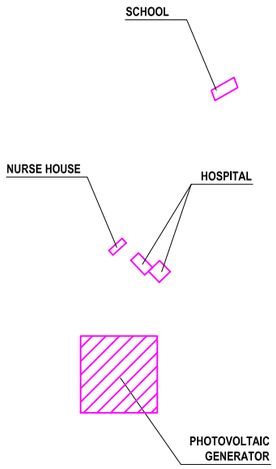
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

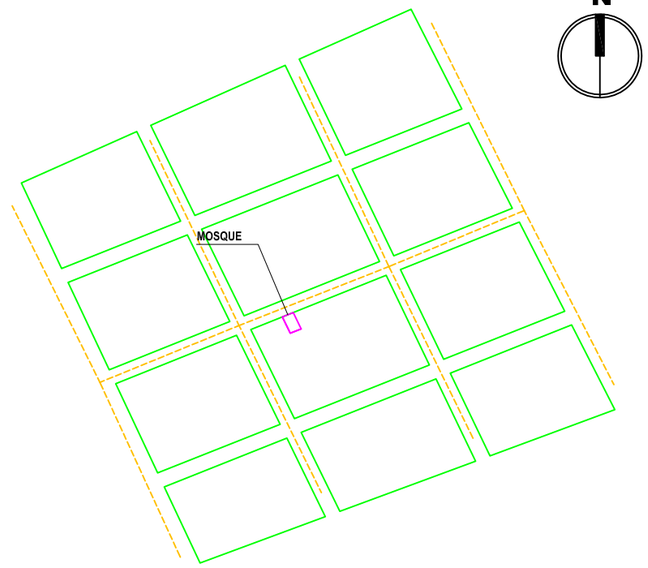
Name: ELECTRIC DISTRIBUTION GRID

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 6.2.1–R00







LEGEND:

PUBLIC LIGHTING LINE

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PUBLIC LIGHTING GRID

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 6.2.2–R00

DOURBALI		
Line	Phases Tri or Mono	Section (Al) [mm^2]
T1	M	10
T2	M	10
T3	T	50
T4	M	6
T5	T	50
T6	M	16
T7	M	16
T8	M	16
T9	T	35
T10	M	16
T11	M	16
T12	M	10
T13	M	10
T14	T	35
T15	T	35
T16	M	16
T17	M	16
T18	M	10
T19	M	16
T20	T	25
T21	M	16
T22	T	25
T23	M	10
T24	M	16

LEGEND:

⊗ POTENTIAL USERS VISITED

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name: ELECTRIC DISTRIBUTION GRID

DOURBALI

Promoted: UNIDO

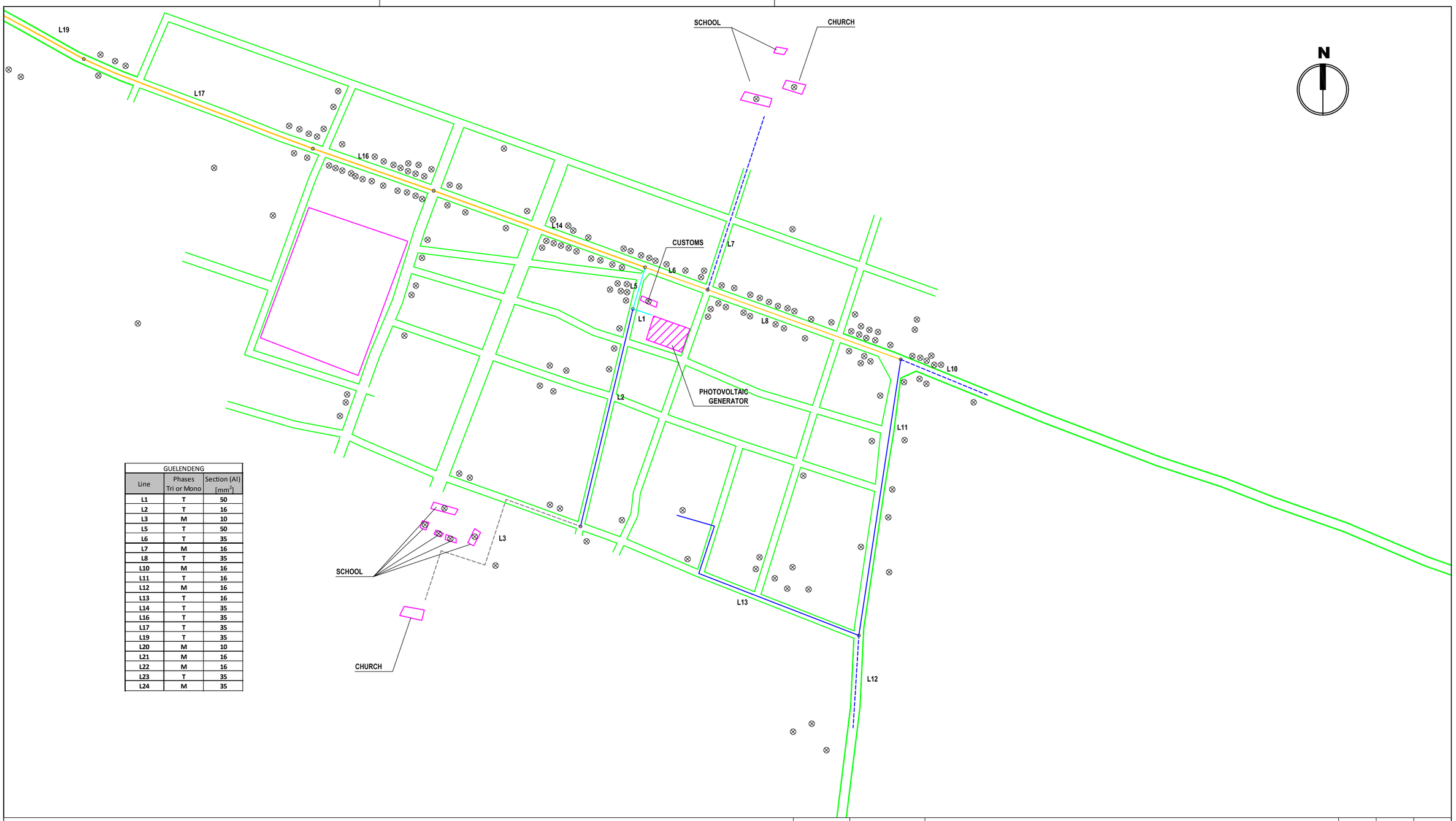
Approved: Engineer Xavier Vallvé

Design: tta Trama TecnoAmbiental

www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 6.3.1–R00



GUELENDENG		
Line	Phases Tri or Mono	Section (Al) [mm^2]
L1	T	50
L2	T	16
L3	M	10
L5	T	50
L6	T	35
L7	M	16
L8	T	35
L10	M	16
L11	T	16
L12	M	16
L13	T	16
L14	T	35
L16	T	35
L17	T	35
L19	T	35
L20	M	10
L21	M	16
L22	M	16
L23	T	35
L24	M	35

LEGEND:

⊗ POTENTIAL USERS VISITED

REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.
R00	28/02/2013		X.R.		

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name: ELECTRIC DISTRIBUTION GRID PART B

GUELENDENG

Promoted: UNIDO

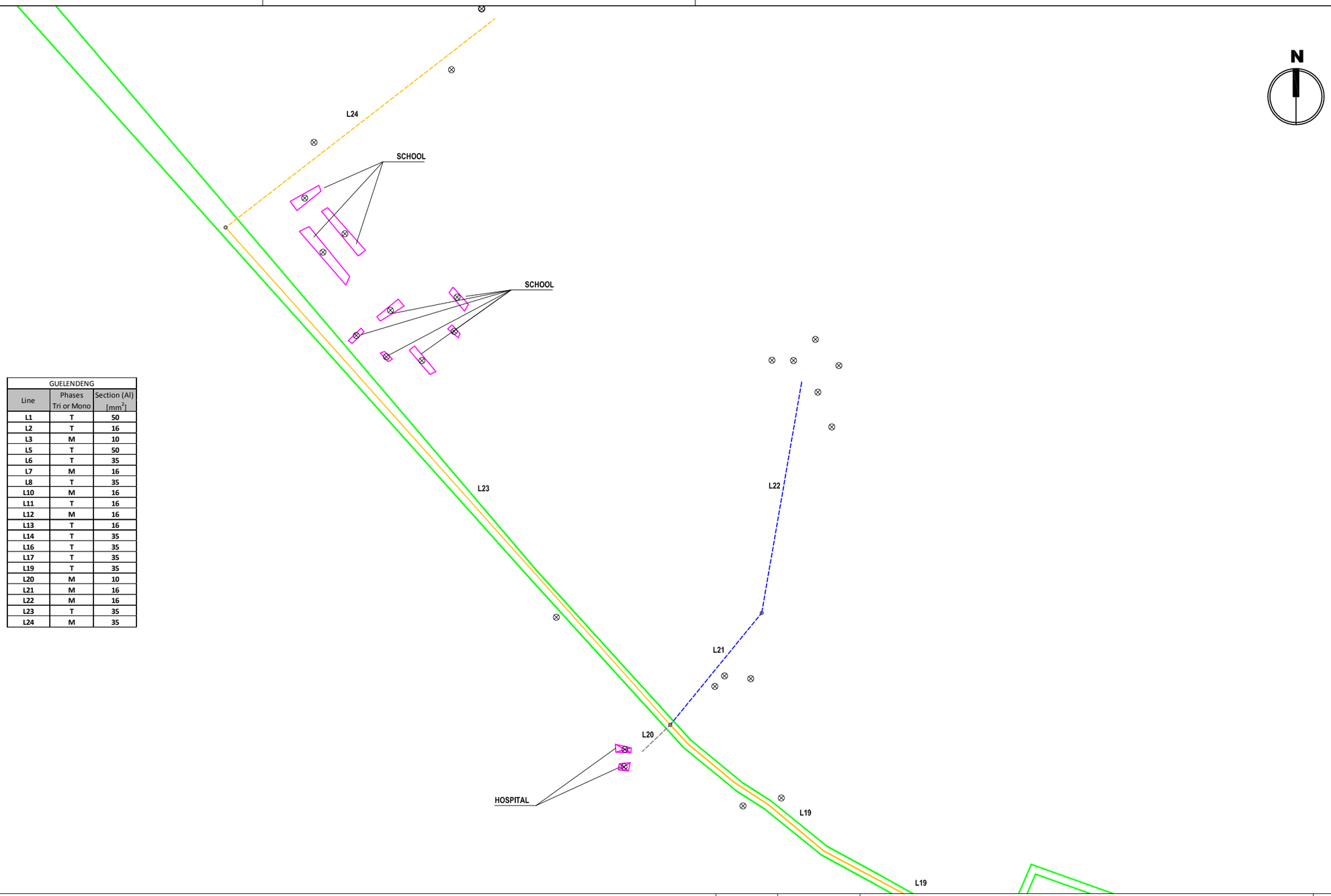
Approved: Engineer Xavier Vallvé

Design: tta Trama TecnoAmbiental

www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 6.4.1–R00



GUELENDENG		
Line	Phases Tri or Mono	Section (Al) [mm^2]
L1	T	50
L2	T	16
L3	M	10
L5	T	50
L6	T	35
L7	M	16
L8	T	35
L10	M	16
L11	T	16
L12	M	16
L13	T	16
L14	T	35
L16	T	35
L17	T	35
L19	T	35
L20	M	10
L21	M	16
L22	M	16
L23	T	35
L24	M	35

LEGEND:
⊗ POTENTIAL USERS VISITED

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:
ELECTRIC DISTRIBUTION GRID PART A
GUELENDENG

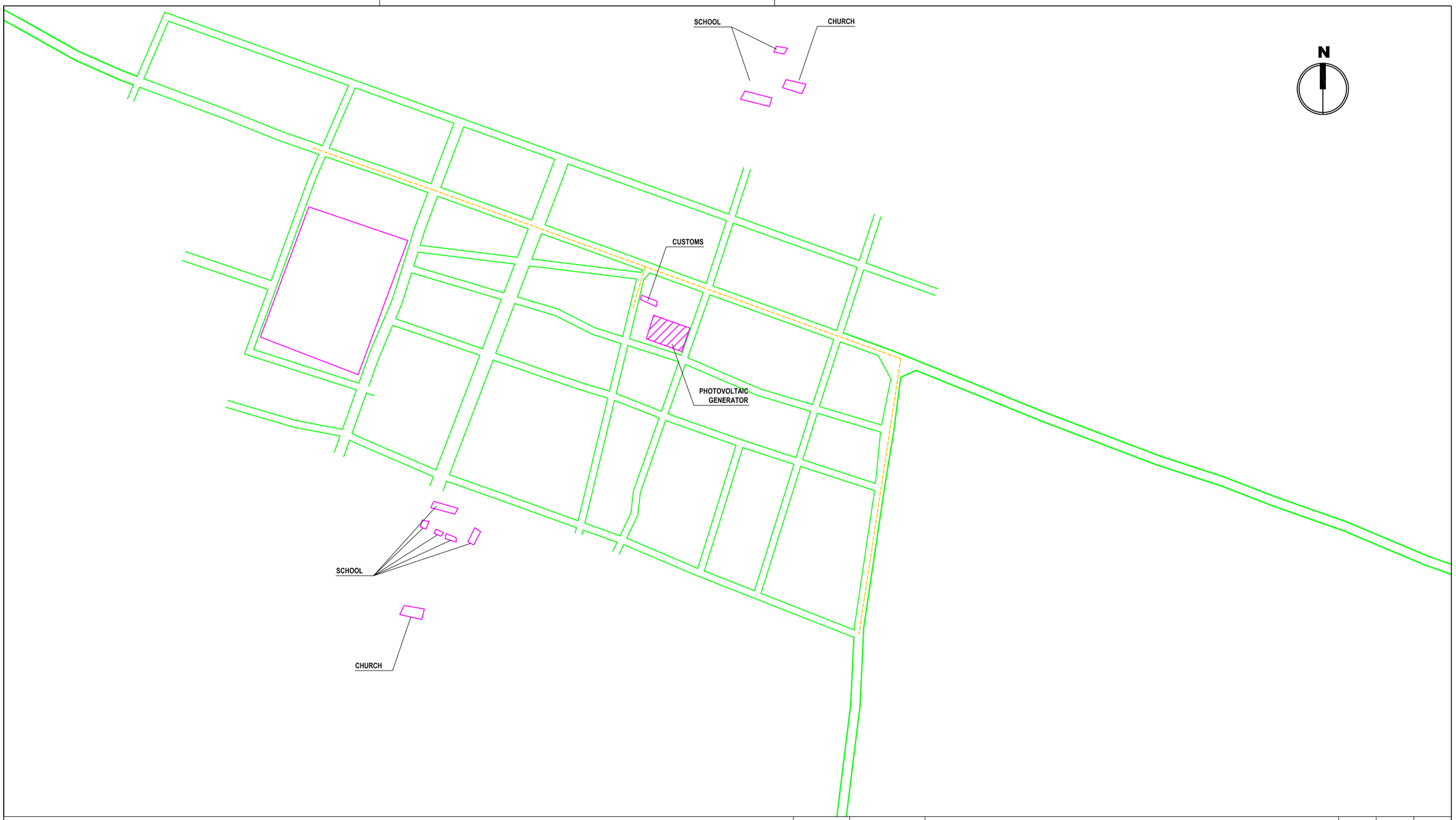
Promoted: UNIDO

Approved:
Engineer Xavier Vallvé

Design
tta Trama TecnoAmbiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 6.4.2–R00



LEGEND:
PUBLIC LIGHTING LINE

REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.
R00	28/02/2013		X.R.		

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:
PUBLIC LIGHTING GRID
GUELENDENG

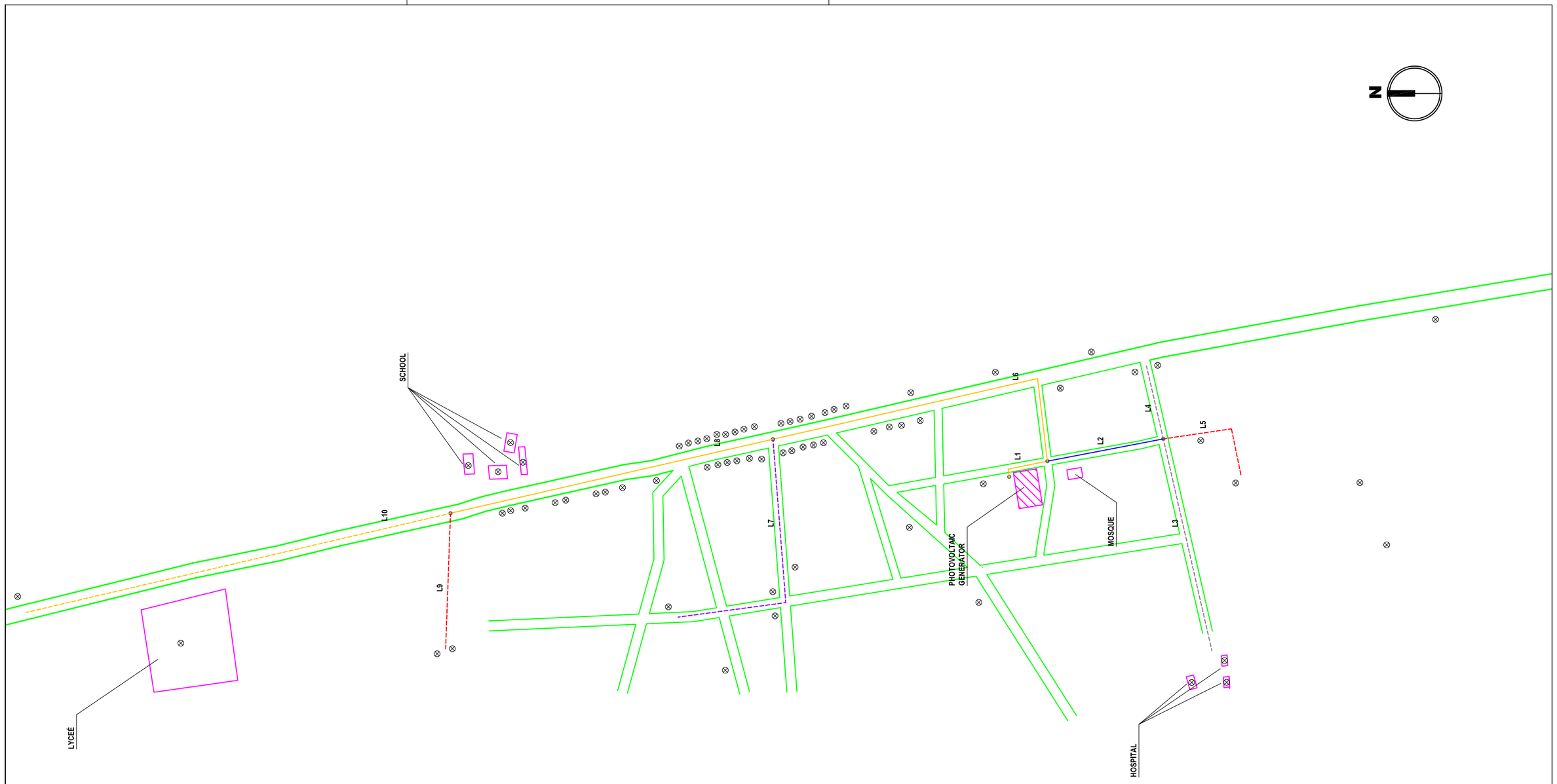
Promoted: UNIDO

Approved:
Engineer Xavier Vallvé

Design
tta Trama TecnoAmbiental
www.tramatecnoambiental.es tta@tramatecnoambiental.es
Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 6.4.3–R00



MAILAO		
Line	Phases Tri or Mono	Section (Al) [mm²]
L1	T	35
L2	T	16
L3	M	10
L4	M	10
L5	M	6
L6	T	35
L7	M	25
L8	T	35
L9	M	6
L10	M	35

LEGEND:

⊗ POTENTIAL USERS VISITED

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

ELECTRIC DISTRIBUTION GRID

MAILAO

Promoted: UNIDO

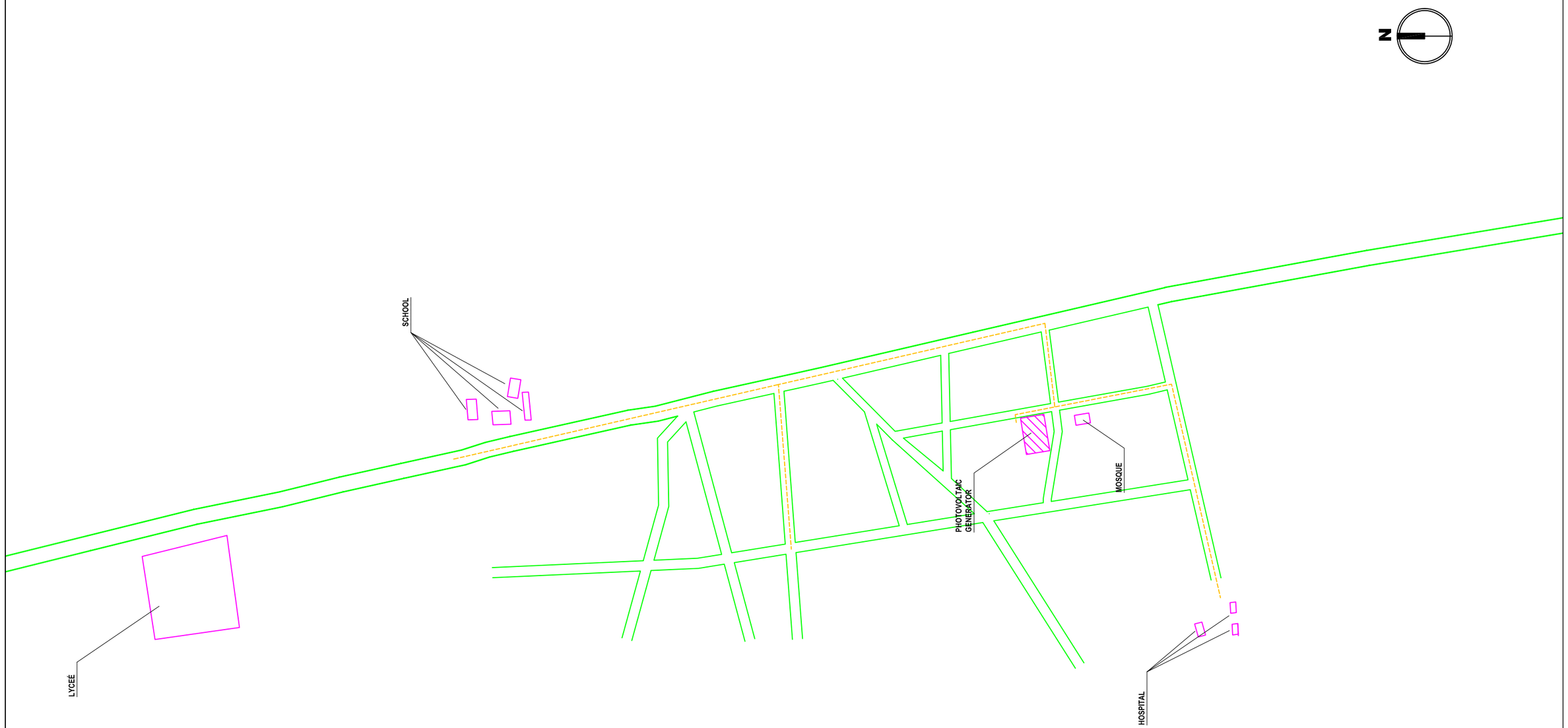
Approved: Engineer Xavier Vallvé

Design: tta tramatecnoambiental

www.tramatecnoambientaLes tta@tramatecnoambiental.es
Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948

Escale: 1:4000

Drawing Number: 6.5.1–R00



LEGEND:
PUBLIC LIGHTING LINE

R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

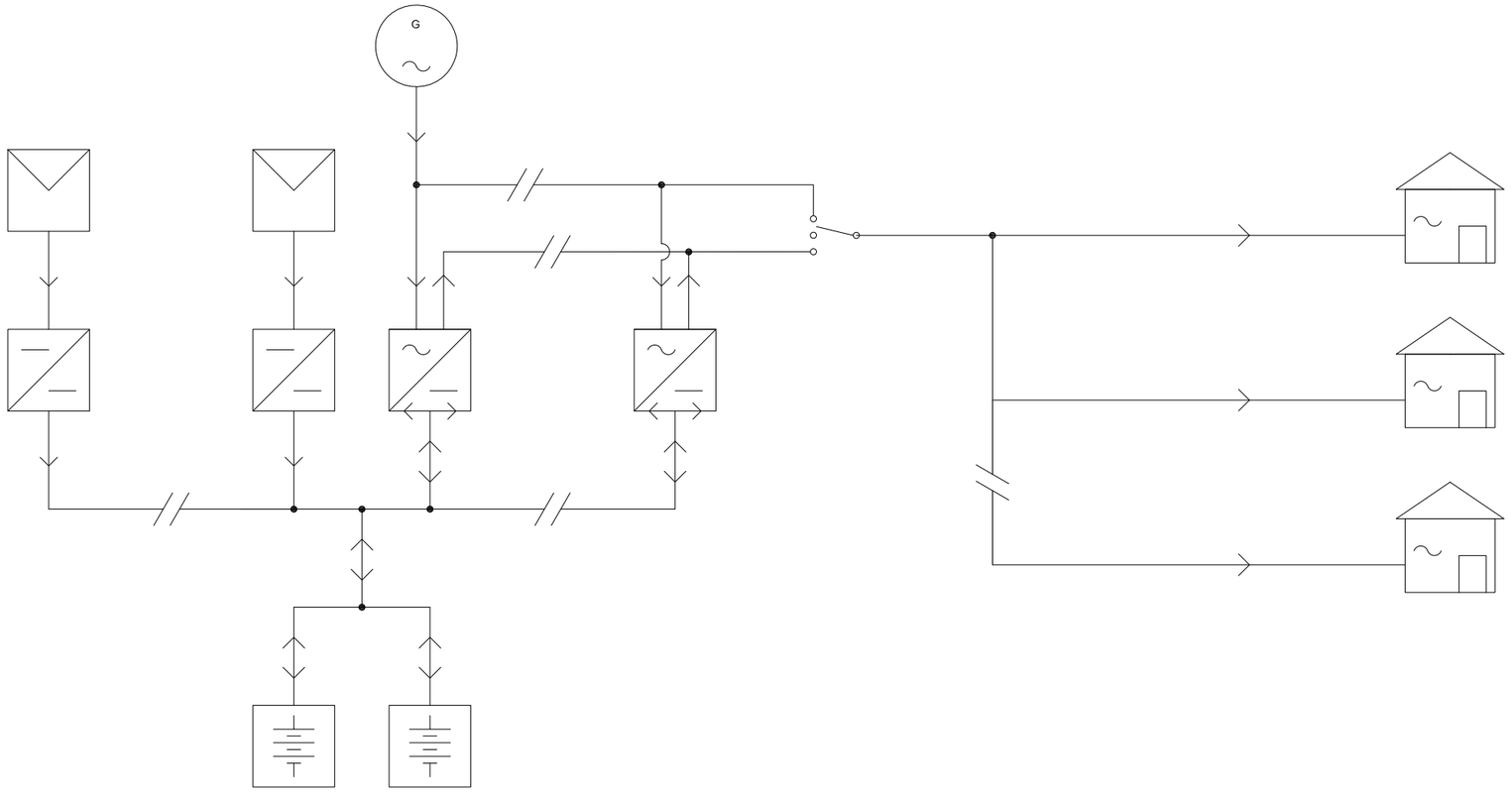
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PUBLIC LIGHTING GRID

MAILAO

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	1:4000 Drawing Number: 6.5.2–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

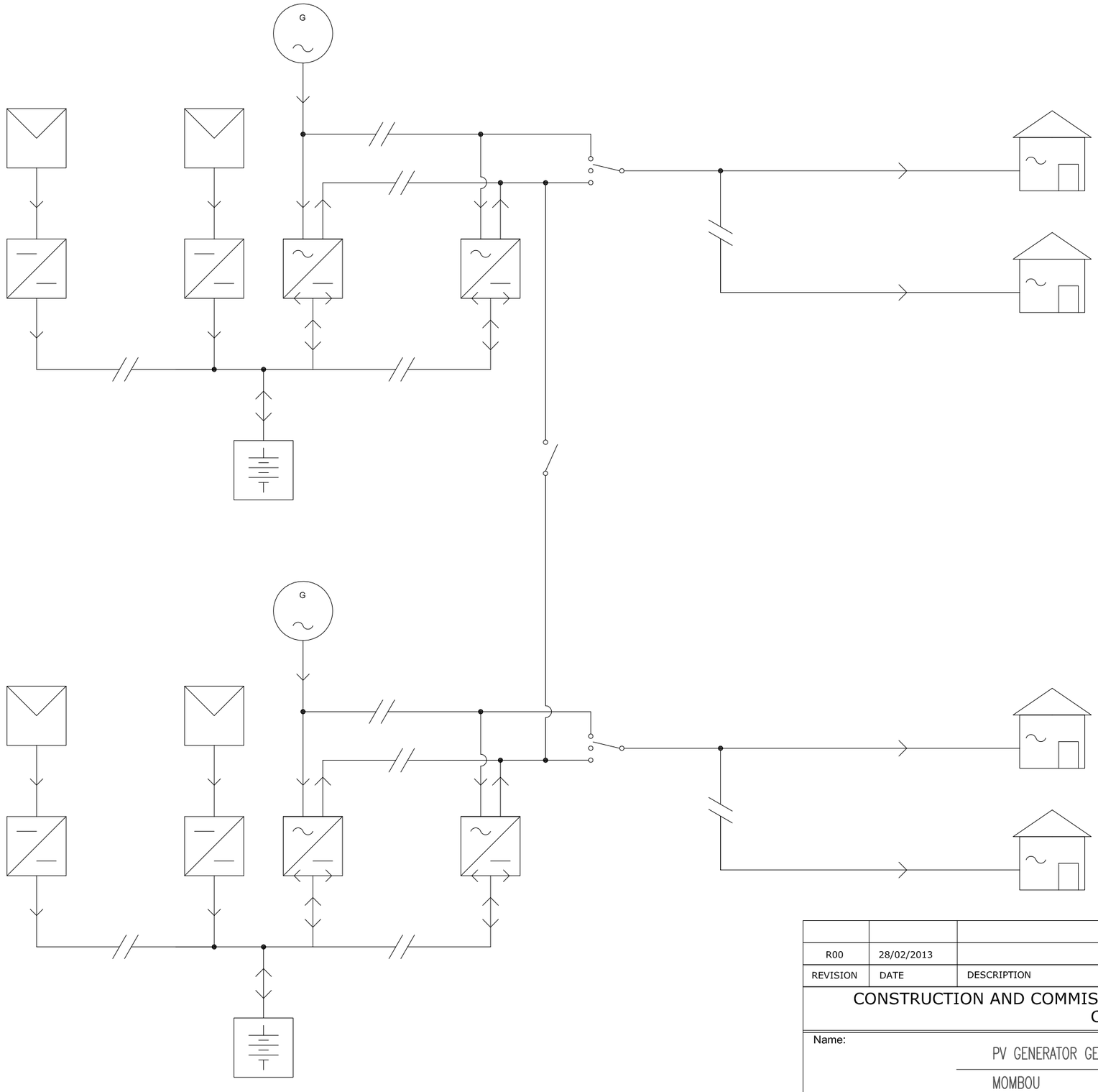
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR GENERAL SCHEME

DOUGUIA

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambental.es tta@tramatecnoambental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	NO Drawing Number: 7.1.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

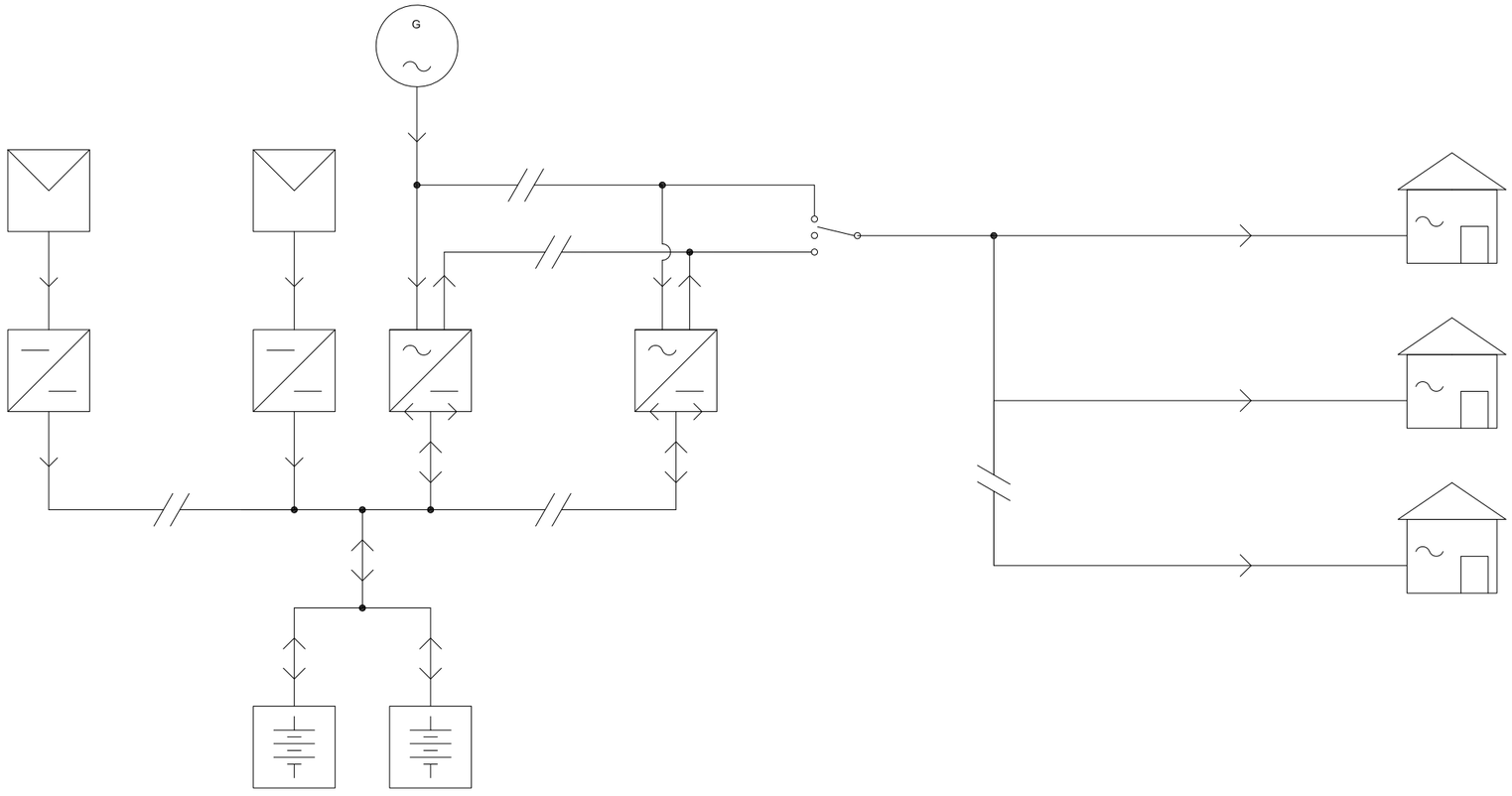
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR GENERAL SCHEME

MOMBOU

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	NO
			Drawing Number: 7.2.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

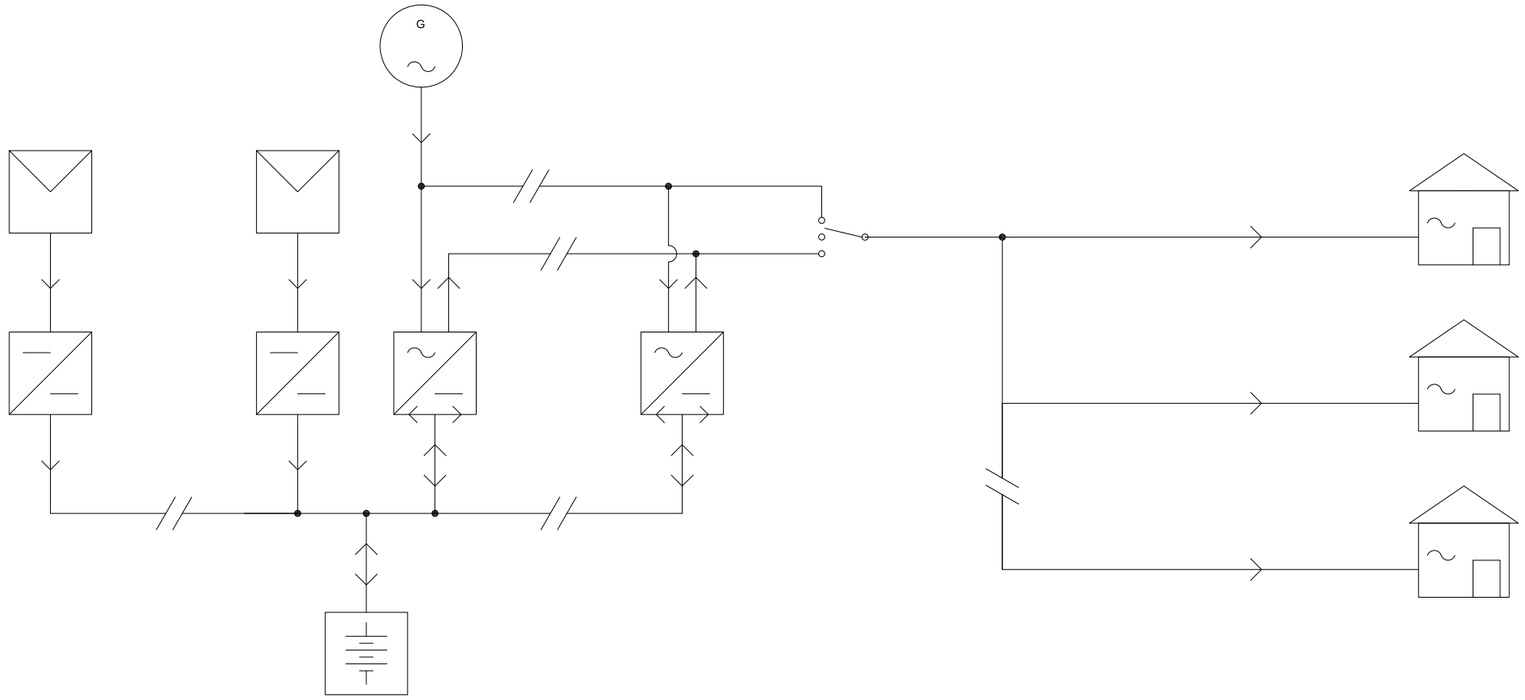
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR GENERAL SCHEME

DOURBALI

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambental.es tta@tramatecnoambental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	NO Drawing Number: 7.3.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

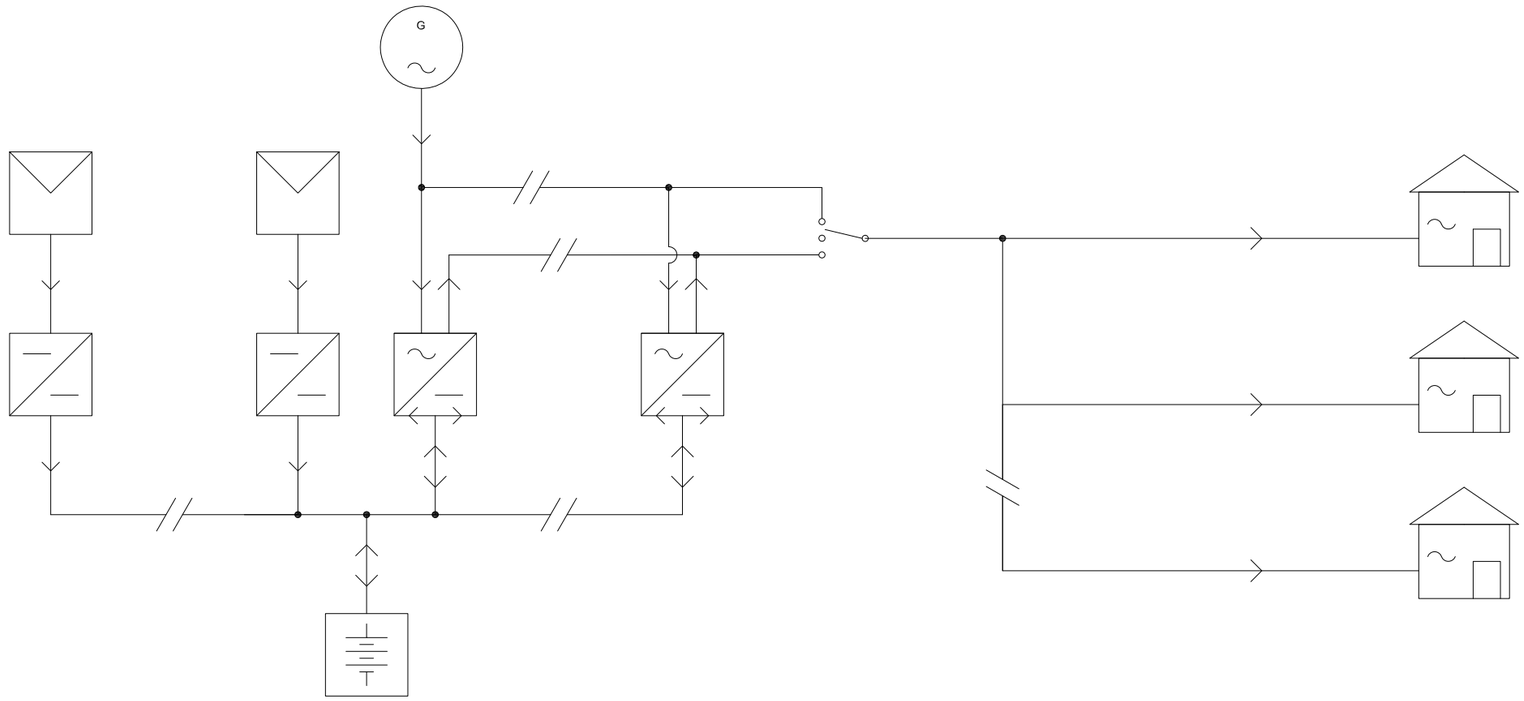
CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR GENERAL SCHEME

GUELENDENG

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambental.es tta@tramatecnoambental.es Av.Meridiana, 153 P,Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	NO
			Drawing Number: 7.4.1–R00



R00	28/02/2013		X.R.		
REVISION	DATE	DESCRIPTION	DRAW	REV.	APR.

CONSTRUCTION AND COMMISSIONING OF 5 SOLAR PHOTOVOLTAIC MINI GRID IN CHAD ON A TURN-KEY BASIS

Name:

PV GENERATOR GENERAL SCHEME

MAILAO

Promoted:	Approved:	Design	Escale:
UNIDO	Engineer Xavier Vallvé	tta Trama TecnoAmbiental www.tramatecnoambiental.es tta@tramatecnoambiental.es Av.Meridiana, 153 P.Baixa 08026 BCN-ES Tel.(+34)93 446 3234 Fax.(+34)93 456 6948	NO Drawing Number: 7.5.1–R00