Terms of Reference (TOR)
Supply, Transport, and Installation of 1.8kWp Solar PV systems in GIZ-Forest4future (F4F) Project Office Arbaminch

January 2023

Terms of reference (ToR) for the procurement of services

giz

Contents

1 Background Information 2
1.1 Background of the F4F 2
1.2 General design assumptions 2
2 Construction details for the 1.8kWp system category 3
2.1 Load profile 3
2.2 System layout and component sizing 4
2.2.1 Specific Design Assumptions 4
2.2.2. PV array sizing: 4
2.2.3. Charge controller sizing: 4
2.2.3. Battery sizing: 4
2.2.4. Inverter sizing: 4
2.3. Summary of system layout and components 5
3 Overview of material required 5

1 Background Information

1.1 Background of the F4F

The project Forests4Future (F4F) is global project to support the implementation of the AFR100 commitments of Ethiopia, Madagascar and Togo. The F4F country package Ethiopia project aims to rehabilitate the ecological and productive functions of degraded terrestrial ecosystems towards landscapes and forests, sustainable wood production, sustainable agriculture, mixed agroforestry systems and the rehabilitation of pastures and wetlands. It strengthens the resilience of entire landscapes and improves the well-being of populations. The project operates in the Lake Chamo and Lake Abaya catchment areas. It will be structured around three fields of action, namely:

1. The capacities of planning and coordination of measures for the Forest and Landscape Restoration (FLR) are improved.
2. Models for implementing scalable measures for FLR have been tested.
3. Small forestry or agroforestry enterprises get equipped, capacitated, and operational.

The intervention areas of the F4F Ethiopia project are selected Woredas in Lake Chamo and Lake Abaya Catchment, Gamo zone, Southern Nations, Nationalities, and Peoples' Region (SNNPR)region.

The appraisal mission made in the catchment for the formulation of the project noted problems related to the management of the landscape in the area of intervention, particularly soil erosion, forest degradation, and siltation in the wetland ecosystem found at the lower catchment inappropriate agricultural system, grazing, forest degradation, the insufficiency or lack of information on the value chains (wood, agroforestry) and the lack of intersectoral cooperation/coordination at all levels.

In order to overcome these various issues mentioned above, the F4F project has been implementing Forest landscape Restoration measures in the landscape.

Context of the assignment

Forests4Future project is planning to install a solar PV system in Arba Minch town project field office envisioned to use as a complementary energy source for office uses and to promote solar technologies as a positive effect on environmental protection. Accordingly, the project seeking a reputable company with the below-mentioned required experience and capability to supply, transport, and install a 1.8kWp solar panel PV system in the specified project office.

1.2 General design assumptions

1) The total system loss is conservatively calculated with 30% from generation to AC output
2) Two days of autonomy are factored into the system layout which is considered to be sufficient given the environmental situation in Ethiopia and which also takes into account the rainy seasons for ensuring a reliable supply of electricity.
3) 60% depth of discharge (DOD) for lead-acid batteries. Even though quality batteries of this kind are usually allowed to be discharged below 60%, GIZ EnDev Ethiopia prefers to stick to a conservative 60% DOD in order to extend the lifetime of the batteries.

4) An average of five peak sun hours (PHS) for Ethiopia is conservatively chosen for the sites, even though this value is likely to be higher in most of rural Ethiopia's regions.

2 Construction details for the 1.8kWp system category

2.1 Load profile

This solar system is planned for backup when there is no grid power and as per the experience in Arba Minch interaprtion of the grid is for a short period. So we suggested load to used from the solar system only for critical loads.

Block No	Service	Type	Power in W	No.	Total Power in Watt	h/day	Use factor on weekly basis	Wh/day average over the week	Remarks
B1		Energy Saving (LED)	7	2	14	8	0.8	89.6	
		Printer	230	2	460	4	0.8	1472	
		Laptop	22	6	132	4	0.9	475.2	
	Veranda Light	Verenda LED lumps	50	2	100	12	1	1200	
		camera	75	1	75	4	0.8	240	
		Danger wire	25	1	25	24	0.5	300	
B2		Printer	230	1	230	4	0.8	736	
		Laptop	22	4	88	4	0.9	316.8	
					0			0	
B3		Printer	230	1	230	4	0.8	736	
		Laptop	22	5	110	4	0.9	396	
GH		Energy Saving (LED)	7	1	7	12	0..9	75.6	
		Mobile Charging	5	1	5	4	0.8	16	
		Total Energy Consumption(A)						0	
								6053.2	

Design assumptions and reasons for the assumption

1. System Loose shall be 25%

The system loose considers up to AC conversion and to be safe with load management of end-users.

2. System voltage 24V

Since the system is more than 1kWp PV system.

3. Two (2) day of Autonomy

Since the interruption of grid is short and there is no possibility to use for continuous power and when we increase the day of Autonomy cost will increase and the better environmental situation in Ethiopia, only two days of autonomy is taken.

4. 60% Depth of discharge

Since batteries are deep discharge batteries and possible to be discharged below 60% it is Economical to assume 60% DoD.

5. An average of 5 PSH for Ethiopian

Although their places where the pick sun hour goes above and below 5, an average 5PSH would be the optimum assumption for Ethiopia. According to NASA data, Arba Minch has almost 5.4.

2.2 System layout and component sizing

2.2.1 Specific Design Assumptions

1. The maximum energy demand is estimated to be 6,053.2Wh/day.
2. System voltage of 24V is sufficient given the overall system size.

2.2.2. PV array sizing:

Given the above data and assumptions, the PV array size is calculated using the formula:

Total Daily Energy Consumption/ (Daily Irradiation*Installation and Equipment Losses)

$$PV\ array\ size = \frac{Total\ daily\ energy\ consumption\ X\ (1 + system\ loss)}{Daily\ irradiation}$$

PV Array Size = 1513Wp =1.8Wp due to intended modular solar system design, 450Wp solar panels shall be used for all systems. Hence four solar panels of 450Wp shall be used for the 1.8kWp system.

2.2.3. Charge controller sizing:

To determine the current size, the maximum short-circuit current of the array is calculated and multiplied by a safety factor of 25% (1.25). Therefore, the LSC of a 300Wp panel is 11.60A. Since there will be two string each with two panel each panel connected in series and the strings connected in parallel total amount of array current of one string is 11.60A remains the same, but when connecting the strings current become 2x11.60=23.2A while the voltage becomes additive.

Result: Charge controller = 1.25* 23.2(PV array current (A)) = 29A, better to be make it 50A

Given the availability of different charge controllers on the market, the charge controller size for the 1.8Wp system size shall be 50Amp.

2.2.3. Battery sizing:

The battery capacity is stated in Amp-hours (Ah). The battery size is calculated as follows. Battery charge-discharge efficiency = 0.9. Two days of autonomy day will be factored in.

$$Total\ daily\ amp - hour = \frac{Total\ daily\ energy\ consumption}{System\ volatge} = 252.2Ah/day$$

$$Battery\ size = \frac{Total\ daily\ amp_hour\ X\ days\ of\ autonomy}{Battery\ charge\ discharge\ efficiency\ X\ DoD} = 708Ah@24V$$

For a minimum of 17KWh@ C10 battery Bank of 708Ah/24V system shall be used

The next available battery configuration on the market consists of six 708Ah@C10, 2V cells.

2.2.4. Inverter sizing:

The inverter size shall be determined from total load of the system with a flexibility range of 25%. If an induction power is included in a load such as a refrigerator 230W, it is better to have an inverter capacity of not less than three times the load of the refrigerator. (3x230W= 690W).

According to the standard capacity ranges offered on the market, the inverter size chosen would be 1.3x1513=1966.9W≈2kW, 24VDC input, and 230V AC output.

2.3. Summary of system layout and components

Given the above estimates, the following system configuration and components is proposed:

No	Total Energy demand	6053.2Wh/day
1	Power supply: system to load	230 V/AC, 50 HZ
2	Technology/ System type	AC coupled
3	PV generator:	1.8kWp system (four mono-crystalline PV modules of 450Wp each)
4	Charge controller:	MPPT Charge controller, ≥ 29A,12V/24V/48VDC ≈50A
5	Battery bank:	Min 17 kWh, 12 pcs of 2V cell, 708Ah@c10), Maintenance free, VRLA, tubular plate, min 3,500cycle at DoD 60 %
6	Inverter:	Pure sine wave inverter, Min 2kW, input 24V DC, 230V AC output, 50 Hz.

3 Overview of material required

The below summary lists the main components that shall be combined into the three system sizes in a modular way. A detailed breakdown of the material is to be found in Annex A.

S/N	Description of material	Specification
1	Solar panel	450Wp
2	Charge controller	MPPT Charge controller, ≥ 16A,12V/24V/48VDC≈50A
3	Battery	2V cell, 708Ah@c10/24V
4	Inverter	Pure sine wave inverter, Min 2kW, input 24V DC, 230V AC, 50 Hz.
5	PV plug	MC4 + connector
		MC4 - connector
6	Fuse box	NH 125A
7	LED lump	50W; 220V-240V, E27 90lum/w
8	Cable	Solar cable, UV proof 1x6mm^2
		Battery cable 1x50mm^2
9	Combiner box	For two-string solar panel

Annexes:

Annex I: Material specifications and bill of quantity

Annex II: Requirement for supply and Installations

Annex III: Required Staff composition