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FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

Environmental and Social Impact Assessments for the Proposed Mini grid Solar Power Plant Project in Telifa, Fogera Woreda, Amhara Region

Equatorial Power Energy Services Private Limited Company

April 2023

Prepared by Veritas Consulting and Geoscience PLC

The Federal Democratic Republic of Ethiopia Environmental Protection Authority

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Executive summary

1. Introduction

Equatorial Power is a next generation developer-operator of DRE infrastructure services, with a viable, and scalable, business model. Equatorial Power goes beyond electrons, to provide an integrated service offering to peri-urban and rural communities. Target customers are households, SME and businesses. Deployment includes productive use assets, for water purification, ice making, fish drying, water pumping, milling, cold storage for dairy other agro-processing. This is a key USP for EP making us much more than a Mini-Grid deployer. Since incorporation in 2017, Equatorial Power has developed an experienced and diverse management team, critical strategic partnerships and institutional relationships with Governments, donors and multilaterals to enable it to achieve its growth targets (Engie, InfraCo Africa, Shell Foundation, Rockefeller Foundation and more). Equatorial Power has active operations in Uganda, DRC, Rwanda and Mozambique, serving circa 30,000 customers via hybrid solar solution. Equatorial Power is currently entering the Ethiopian market to expand its value proposition to provide clean power to rural communities as well as bigger off takers such as irrigation systems.

2. Overview of the Project

Ethiopia depends on electric power generated from large hydropower stations to propel its economic growth and provide energy for domestic uses. To meet the rising demands for energy in rural areas where access is limited, the National Electrification Program 2.0 (NEP 2.0) suggests off-grid electrification. This is particularly important for Ethiopia's rural settlements which are often dispersed and inaccessible.

The mini grid is a stand-alone AC coupled solar photovoltaic (PV) system which is meant to provide reliable power supply to the community and to an irrigation system which will replace the diesel pumps currently used by farmers for irrigation. Once completed, the project is expected to go into commercial operation in September 2023 and supply electricity to smallholder farmers for irrigation purposes. The impacts of the mini-grid system project components were identified and addressed in this Environmental and Social Impact Assessment (ESIA) report for the project site of Telifa in the Amhara National Regional State.

Goals and Specific Objectives

The broad goal of the Environmental and Social Impact Assessment (ESIA) is to provide decision-makers and project proponents with information on potentially significant environmental and social impacts and risks associated with the proposed mini-grid solar power plant project the at Telifa site. The specific objectives are: to identify potential positive and negative impacts of the proposed project; to suggest mitigation and enhancement measures for the identified significant adverse and beneficial impacts; to provide management and monitoring plans and to ensure that the proposed complies comply with the national environmental regulations and African Development Bank's integrated safeguards system.

Project components and main activities

The mini grid solar system includes the following components: a mounting system which will be used to mount PV modules on structures made of aluminum or hot-dip galvanized steel. While the mounted PV panel modules absorb the sun's rays as a source of energy to generate electricity, inverters will be used to convert the Direct Currents (DC) produced by PV modules to grid-exploitable Alternative Currents (AC). Then, transformers will change voltage levels from low voltage (230V) to medium voltage (15kV or 33kV) and vice versa. Finally overhead distribution lines mounted on wooden poles will be used to transfer power from the solar power plant to households and irrigation pumps.

Project alternatives

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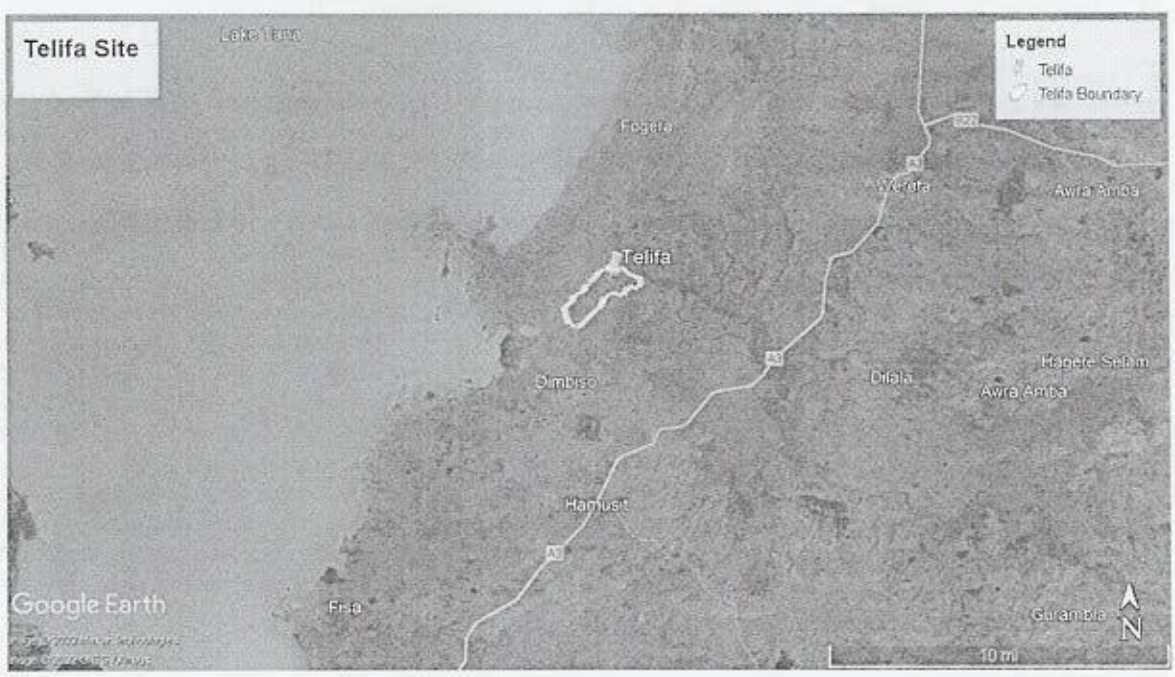
- Several project options were examined to select the feasible alternatives considering biophysical, socioeconomic, and technical factors. The alternatives considered were;
- no project alternative,
- project location alternatives,
- other sources of power (Hydro, Fuel, and Wind): and
- Project implementation option.

All the above-mentioned alternatives were analyzed based on technical feasibility, economic viability, and environmental acceptability. After comparing the above-mentioned alternatives based on technical feasibility, economic viability and environmental acceptability, the project implementation option using solar energy was selected because of the numerous project advantages to the local community, low negative impacts of the project on the social and biophysical environment

3. Description of Project Area

Project location

Telifa is located at 11.87 N 7.57 E in Fogera Woreda, south Gondar zone, Amhara national regional state. The proposed Telifa site can be accessed through the Bahirdar-- Gondar asphalted road. The shortest route to Telifa site is 14 km SSW from Wereta town (see Figure 1 below).



Baseline conditions

Telifa and its surrounding area is characterized by bimodal rainfall distribution with a main rainy season from June to October and a small rainy season from February to March. The average rainfall for the nearest meterological stations in Bahir Dar is about 102 mm while average temperature is 26°C. In situ measurement of temperature was taken from 06/10-09/10/2021 and the temperature records were 26-27°C. The proposed project site is part of the

tertiary and quaternary volcanic rocks and lake shore unconsolidated recent alluvial-lacustrine deposits of quaternary age. As a whole, the topography of the target area is part of the Fogera plain. The soil in the area is weathering product of alluvial lacustrine sediments and tertiary and quaternary volcanics as well as organic humus. Soil samples were taken from Telifa project and analyzed to determine the levels of macro and micro-nutrients. The soil in Teflifa is slightly acidic with a pH of 6.28. The test results for the micro-nutrients of Fe, Mn, Cu and Zn are reported to be 51.4 mg/kg, 39.17 mg/kg, 2.03 mg/kg and 1.21mg/kg, respectively. The FAO plant nutritional reference values for iron 20-30mg/kg, 20-3000 mg/kg for manganese, 15 to 40 mg/kg for copper and 25 to 200mg/kg for zinc. Compared against the reference value Fe is higher than the appropriate normal value whereas the soil content of Cu and Zn are low. Similarly, the FAO reference value for Na in soil should be less than 180mg/kg but Telifa soils have slightly higher concentration of Na (200mg/kg). Similarly, the Labouratory results of Mg and K are greater than the expected normal values in soil.

Water quality investigations were also conducted during the ESIA baseline studies. Analysis of samples indicates that the surface water sources have detectable issues of water quality such as turbidity and manganese for Telifa site. .

SELECTED PARAMETERS OF WATER QUALITY TESTS FOR TELIFA SITE

No	parameters	Unit	Telifa	WHO maximum limit	Remark
1	Turbidity	NTU	181	5	Unacceptable
2	EC	uS/cm	85.4	2000	
3	PH	log10	7.09	6.5- 8.5	
4	TDS	ppm	42.6	1000	
5	Nitrate, NO3	mg/l	0.26	10	
6	Total hardness	mg/l CaCo3	70	300	
7	Manganese	mg/l	0.14	0.1	Unacceptable

Trees are grown scattered within and around farmlands, and homesteads. Indigenous trees such as *Cordia africana, Juniperus procera, Croton macrostachyus*, and *Vachellia sp.* were frequent in the area but *Eucalyptus globulus* dominate the landscape.

Regarding the socio-economic baseline, the settlement in Telifa is a densely packed with nucleated village houses. The farmers practice both rainfed and irrigation activities. The main crops grown include cereals (e.g., wheat, teff, etc.) and vegetables, the latter mainly for urban markets. Only health posts are available near the site, but a health center and primary hospital are found at Woreda capital town. Regarding education services, access is quite good for the primary level (Grades 1-8). For example, primary level education coverage is 90.48% whereas it was only 33.81% for secondary level (Grade 9-12). The proposed project site doesn't have access to electricity from the main grid, but there are certain members of the community who use solar energy for home lighting. With regard to physical cultural resources there are several churches and monasteries in Telifa village and in Fogera Woreda. However, most of these are found outside the potential irrigation areas and perhaps solar power plant will provide them with a potential source of power. The ESIA team did not observe any evidences of archaeological/historical heritages that would potentially be adversely affected by the project implementations. Nevertheless, as always, there is a risk that cultural/archaeological heritage relicts may be unexpectedly uncovered during construction activities. Hence, excavation works should be done carefully as per World Bank Guidelines - OP 4.11 and chance find procedures would be prepared.

4. Institutional and Legal frameworks

As part of the ESIA study, a review of the policies, laws, and institutional arrangements that govern environmental protection and the ESIA system in Ethiopia has been carried out. The ESIA study also considered the African Development Bank Integrated Safeguard System and applicable Safeguard Policies.

With regard to institutional arrangements for the implementation of ESIA, the Ethiopian Environmental Authority (EPA) is mandated to formulate or initiate and coordinate the formulation of strategies, policies, laws, and standards as well as procedures and upon approval monitor and enforce their implementation. It is also responsible for the synergistic implementation and follow-up of international and regional environmental agreements. EPA is mandated to review, approve ESIA reports and issue the environmental authorization. The EPA also undertakes the role of certification of ESIA practitioners. The EPA has its tentacle office at regional levels as well. Moreover, regional bureau of Agriculture, irrigation and pastoral development, Women's office, and mines and energy were reviewed.

Regarding the policies, proclamations, regulations, and guidelines issued by the government of Ethiopia and the AfDB, the ones outlined below, *inter alia*, are relevant to the proposed projects:
Constitution of The FDRE, National Energy Policy of Ethiopia, Water Resources Management Policy, National Conservation Strategy of Ethiopia (CSE, 1997), Environmental Policy of Ethiopia (1997), Ethiopian Women's Policy, Health Policy of Ethiopia, Environmental Impact Assessment (Proclamation No. 299/2002): Environmental Pollution Control (Proclamation No. 300/2002), Public Health Policy (Proclamation No. 200/2000): in addition, the ESIA team has also reviewed the African Development Bank Operational Safeguards Policy.

Concerning the AfDB safeguard policies five Operational Safeguards (OS) were established and are summarized here as extracted from the AfDB ISS Policy Statement 2013.

OS1 Environmental and Social Assessment: This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements. The proposed projects are Category 3 projects as they are less likely to have site-specific environmental and/or social impacts. Likely, negative impacts are site-specific, largely reversible, and readily minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards.

OS2: Involuntary Resettlement: Land Acquisition, Population Displacement, and Compensation: This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement and it incorporates refinements designed to improve the operational effectiveness of those requirements. As the risk category of the project falls under category 3 the project does not trigger OS 2 and hence resettlement action plan and livelihood restorations are not needed.

OS3: Biodiversity and Ecosystem Services: The overarching objective of this safeguard is to conserve biological diversity and promote the sustainable use of natural resources. This safeguard could be triggered due to trade-offs of ecosystem services where the availability of solar energy may result in increased withdrawal of water for irrigation (to increase agricultural production) at the cost of regulatory services such as draining wetlands which are carbon sinks and biodiversity hotspots.

OS4: Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials, and Resource Efficiency: This safeguard covers the range of impacts of pollution, waste, and hazardous materials for which there are agreed-on international conventions and comprehensive industry-specific standards that other multilateral development banks follow. The solar mini-grid power plants are meant to curb pollution which is already underway through diesel pumps for irrigation.

OS5 Labour Conditions, Health, and Safety: This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights, and protection from abuse or exploitation. It covers working conditions, workers' organizations, occupational health and safety, and avoidance of child or forced Labour. Construction and decommission of mini-grid power plants facilities may temporarily attract a medium Labour force. Unfortunately, workers may not be properly informed of their rights and work conditions.

5. Project impacts

Solar mini-grid power plants generally considered to have low environmental and social risks and impacts compared to many other energy or industrial developments due to their short construction phases and insignificant emissions to air, water, and soil during operations. The major positive impacts of the mini-grid projects include:

- Employment opportunities for skilled and non-skilled Labour,
- Provision of reliable electric power supply to farmers,
- Reducing greenhouse emissions to the atmosphere by replacing diesel pumps,
- Enhancing agricultural production and productivity,
- Improving local livelihoods by supplying electricity to communities.
- Enhance women's empowerment and gender equality

The project's negative impacts on the bio-physical environment of the three selected sites include clearing of vegetation for the solar power plant installation, risks of contamination of water and soil from the disposal of hazardous wastes (including PV panels), and increased water consumption for cleaning the solar panels. However, most of these potential impacts are minor or insignificant and their impacts could be avoided or mitigated through proper implementations of the proposed Environmental and Social Management and Monitoring Plans (ESP).

The project's adverse impacts on the socio-economic environment may include increased prevalence of HIV/AIDS and other infections/diseases and Covid 19 due to the influx of workers. Similarly, temporary Labour influx, especially during the construction phase, may result in gender-based violence (GBV) and sexual exploitation risks for women and girls. In addition, the employment of children below 15 years of age could be an issue requiring monitoring protocols and administrative mechanisms. However, GBV and associated impacts will likely be minor during the operation phase since the minigrid will only be providing electricity to clients and does not involved an external labor force. In the meantime, water resource competition could potentially arise in the three proposed sites which would eventually call for formal and informal conflict resolution mechanisms.

Finally, fire hazards, workplace accidents, and injuries, and traffic accidents to workers and local communities were among the identified negative impacts of the proposed mini-grid solar power projects during the construction and decommissioning phases of the project.

6. Public consultation

Consultations were conducted with woreda officials and local people in the project area. The public consultation meeting was undertaken in the project kebeles during which the attitude of the community was assessed. It was very helpful to obtain basic information on the socioeconomic, sociocultural, and biophysical impacts of the project and the associated measures to be taken. The discussion was participatory in that the participants expressed their views, concerns, and suggestions without reservations about the proposed solar project. The minutes of the public consultations are annexed to the main report of this document.

Date of meeting: 07/10/2021
Place of meeting: In the compound of Saint Merry Church at Telifa site
Number of participants: Men 67 Women 21

Name of participant	Issues raised	Responses
Ato Atinafu Yimer (M)	Expressed that he has information about the project earlier and he is happy as his village is selected for the solar power plant pilot study. He said, "his community does not see any adverse impacts of the solar power plant project, rather it will open up opportunities to increase productivity and other business ideas". The community will be happy if the projects commence as soon as possible	In fact, there was another technical group that selected this site. The site was selected based on many criteria such as land suitability for irrigation, water availability for irrigation, regional government and farmers, productivity, problems related to fuel etc. Now, we are here to study the ESIA related to the construction and operation of this project. So, this discussion is one of the main parts of our study and your view is important for our report and we appreciate it.

Ato Alemu Abera (M)	He welcomed the advent of the proposed solar power plant project to his community. Most of the community members, he said, are exhausted in their effort to secure diesel for their irrigation. Diesel is not only expensive but also not available. If his private farmland is selected for solar panel installation, he is willing to give it and he added that they do not have any objection to this project and they are ready to provide support including Labour.	The issue raised is very important and useful for planning and implementation activities and should be considered. Particularly, the issues raised concerning land for solar panel installation as well as Labour support are remarkable and valued. However, the land will not be taken away for free, rather proper compensation will be paid according to the law of the land.
Ato Melese Abera (M)	He expressed that this project seems to bring with it happiness to all villagers if it materializes soon. He added that our ladies will get relief from smoke, the farmers have been selling out grains and even oxen to purchase diesel. He said we pray this project comes as quickly as possible to the Telifa village.	As the ESIA team expressed earlier, the purpose of this project was to alleviate the problems related to irrigation and power supply to households. For the success of the proposed projects, the community's support is of great importance.
All women participants	Acclaimed their support with hand clapping	All women present in the meeting extended their interest to participate but our efforts to encourage them to speak further did not go beyond the acclaimed acceptance of the upcoming project
All participants (M & F)	All the above respondents raised any potential source of gender-based violence including sexual exploitation of women for short term benefits	The ESIA team responded that gender-based violence is a serious offense and the potential project proponent will have a protocol including training manuals to sensitize and monitor it. If it happens in some way there will be administrative and disciplinary mechanism to address the offenses

7. Environmental and Social Management Plan

The minigrid power plant, generation and distribution, and customer connections will be managed by the Minigrid Developer, with construction done by the Minigrid Contractor. The local government and municipality bodies will be involved as well as and where appropriate.

This ESIA seeks to address all potential impacts and risk mitigation activities that any of the above entities may be involved in. The following table seeks to delineate which entity will be responsible for impacts and mitigation.
The cost estimates provided in the below reflect expected costs over the 20-year estimated lifetime of the minigrid project.

Phases	Category of impacts	Main Identified Impacts	Impact Significance	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
Construction		Loss of land or property	Low Negative	Compensation should be paid following the relevant government compensation proclamation. Timely communication with the affected people before the commencement of the project and if any disputes arise grievance redress management should be put in place	Minigrid Developer/Regional government	Exact siting for solar panels is not identified yet
		Traffic Accident	Medium Negative	Ensure all drivers follow mandatory speed limits not exceeding 30km per hour Educate all drivers and construction site workers on applicable laws and road safety practices	Minigrid Contractor, in collaboration with Woreda traffic office	Internal safety training and traffic signposts 40,000Birr
		Noise Pollution	Low Negative	Noisy activities shall be scheduled to daytime hours Personal protective equipment such as ear mufflers/plugs should be used during construction works	Minigrid Contractor	PPE 30,000 Birr
		Gender- based violence / Potential child labour	Medium negative	Community sensitization, regular monitoring for compliance	Community /woreda labour and women affairs office	Costs for GBV training (manual, etc) 100,000 Birr
		Impact on public health including Covid 19	Medium Negative	Conduct public health awareness campaigns addressing issues of behavioural change on HIV/AIDS and STDs etc. Provision of materials useful for the prevention of HIV/AIDS.	Woreda health office	Costs for awareness campaign, PPE etc 25,000 Birr

Phases	Category of impacts	Main Identified Impacts	Impact Significance	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
		Public health and safety training for day labourers	Medium Negative	Provision of training for workers on sexual harassment and GBV policies Workers should follow strictly Covid19 prevention protocols	Minigrid Contractor	Cost for half day internal training 30,000 Birr
	Biophysical environment	Generation of solid and liquid Wastes	Medium Negative	Hazardous waste should be disposed of in accordance with best industry practices. Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean. The wastewater from sanitary and construction works should be collected through a channel in a plastered pond or reservoir and can be recycled for construction, green area, and other purposes after proper filtering and treatment	Minigrid Contractor	Cost for waste disposal 150,000 Birr
		Air pollution	Low Negative	Workers assigned in the construction should wear a dust mask. Water shall be sprayed on all internal roads to minimize dust dispersion when necessary	Minigrid Contractor	Cost for PPE already included above, for water spray 30,000 Birr
		Soil erosion	Medium Negative	Avoid excavation during the rainy seasons Heap the excavated soil in the selected area and reuse it to fill undulating areas	Minigrid Contractor	Labour cost to pile up soil is 60,000 Birr
		Impacts on cultural, historical and archaeological site	Medium	If, in case, during excavation works a religious or historical site is found or suspected to be found , Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of the construction procedure manual	Minigrid Contractor, supervised by Oromia regional state culture and tourism office	Supervision cost 20,000 birr contingency
Operation Phase	Human Environment	Employment opportunity	Medium Positive	Hire workers from local people	Minigrid Developer	No separate cost is implied
		Knowledge transfer	Medium Positive	Provide training to local workers	Minigrid Developer	No separate cost is implied
		Electric supply	High positive	Provide electric for local people	Minigrid Developer	No separate cost is implied
		Fire hazards	High Negative	The solar PV plant should be equipped with proper extinguishers for firefighting The technician should regularly inspect Solar PV and power plant components	Minigrid Developer	Cost for fire extinguishers 80,000 birr
		Occupational health and safety	Low Negative	Use of appropriate PPE during maintenance The solar PV plant shall be equipped with fire-extinguishers Ensuring all electrical equipment and machinery are properly grounded Maintenance should be conducted by trained professionals only	Minigrid Developer	Costs for PPE, maintenance over project lifetime 60,000 Birr
	Biophysical Environment	Liquid waste	Low Negative	Construct a toilet inside the power site premise and collect sanitary waste and finally dispose it off at permitted area when needed	Minigrid Contractor	No cost implied here since toilets/septic tank will be constructed during the construction phase

Phases	Category of impacts	Main Identified Impacts	Impact Significance	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
		Employment opportunity	Low Positive	Hire workers from local people	Minigrid Developer	No major cost is implied – this is within the business model operation costs
Decommissioning phase	Human Environment	GBV/Child labour	Low Negative	Provide training for families/ communities	Community/Woreda labour and women's affairs office	Training cost 20,000 Birr
		Loss of employment	Low Negative	Transfer permanent workers to other active projects or be absorbed into other government offices Pay compensation (severance) fee for permanent workers to be done in accordance with company contracts and applicable labour law	Minigrid Developer /Regional government	Compensation payment for workers should be paid by project proponent
		Solid Waste	Low Negative	Hazardous waste, including broken PV panels, used batteries, shall be disposed of in accordance with best industrial practices	Minigrid Developer	Waste disposal cost 150,000 Birr
	Biophysical Environment	Air Pollution	Low Negative	Workers assigned to the demolition should wear dust masks. Spray water during demolish work	Minigrid Developer	PPE for workers 40,000 Birr
		Air Pollution	Low Negative	Workers assigned to the demolition should wear dust masks. Spray water during demolish work	Minigrid Developer	PPE for workers 40,000 Birr
Monitoring Costs						150,000
Total Minigrid Developer / Contractor						720,000 Birr
Total other parties/ multiple parties combined Only						**245,000 Birr**
Total Combined Cost						**965,000 Birr**

Environmental and Social Management and Monitoring Plan (ESMMP)

ESMMP has been prepared for addressing all adverse impacts of the implementation of the mini-grid projects. The ESMMP presents in detail impact categories, their mitigation measures, institutional responsibility, and indicative budget. The proposed management and monitoring measures can easily be implemented with available resources and expertise. The proponent is responsible for financing and coordination of the ESMP for the solar and irrigation project. The contractor and all project employees should be among the main actors, especially during the construction phase when they are required to act as agreed on the contract document and this ESIA study. The Amhara Region Environmental Authorities are the regulatory body responsible to review EIA, monitoring, auditing, enforce and guide its implementations.

Parameters to be monitored	Mitigation measures	Responsible	Monitoring schedule	Monitoring indicators	Monitoring cost (Birr)

Parameters to be monitored	Mitigation measures	Responsible	Monitoring schedule	Monitoring indicators	Monitoring cost (Birr)
Contract management	Make sure the contractor has prepared ESMP for approval by the client	Proponent	Pre-construction and construction phases	Copy of the approved ESMP and implementation of it	Cost internal to developer to get approvals
Social support to vulnerable people	Job opportunities for project-affected people (loss land), Landowners should be compensated as per proclamation No. 1161/2019	Proponent	Throughout operation phase Note: selected land is expected to be community land, not individual	Interview vulnerable people, field visit, Check the amount of money paid out from finance	Supervision cost 5,000 birr
Employment opportunity	Hire workers from local people depending on their education preparedness and skill level	Proponent & Woreda	At the beginning and annually months	Number of local workers from company human resource office	Supervision cost 5,000
Solid waste	Hazardous waste, including broken PV panels or panels at the end of their use-life, shall be disposed of in accordance with best industry practice Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean	Proponent	Quarterly during construction and annually in operation	Annual site visit to determine if any hazardous waste is on site Disposal of hazardous waste in compliance with waste management procedures	Supervision cost 10,000
Liquid waste	Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills The wastewater from sanitary and construction works should be collected through channels in a plastered pond or reservoir and should be recycled for reuse during construction	proponent	Beginning of construction and annually each year of Operation	Annual check that the necessary are in place Constructed plastered pond/ reservoir if required Amount of water recycled	Supervision cost 10,000
Noise pollution	Noisy activities shall be scheduled to daytime hours personal protective equipment such as ear mufflers/plugs will be used	Proponent in collabouration with Woreda health experts	Weekly during the construction phase	Noise level should not exceed the world bank standard (55dBA and 45 dBA during the day and night times, respectively)	Cost for regular checking of noise level 5,000
Air pollution	Workers assigned in the construction should wear dust masks. The supervisor should strictly follow and make sure this procedure is in place before starting their job; and Water should be sprayed on all internal roads to minimize dust dispersion when necessary	proponent collabouration with Woreda health experts	Periodically during the construction and operation phase	Check air quality measurement, Air emission shouldn't exceed WHO standards Supervise workers proper use of PPE's Complaints from the local governor, community	Expert cost for regular check emission level 5,000
Loss of farm and grazing lands	Landowners should be compensated as per the new proclamation No. 1161/2019 before the construction activities started Provide priority to a job opportunity for those projects affected people (PAP) during construction and implementation phases	Proponent	Before commencement of construction work	Check the amount of money paid for PAP Contractor's personnel office documentation	No cost
Traffic accident	Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages) Mandatory speed limits not exceeding 40km per hour Collabourating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)	Proponent collabouration with Woreda traffic police	Every three months during construction, annually during operations	Number of accidents on the site Speed limits put at appropriate places Erected traffic sign	Supervision cost 5,000
Sexually transmitted diseases like HIV	Health promotion: sensitization of both community and workforce Provision of materials useful for the prevention of HIV/AIDS Having in place an appropriate signpost to educate the workforce and community about the Project's HIV policy	Woreda health office	Every month during the construction and operation phase	Number of distributed condoms Check the number of trainings conducted	Training cost 100,000

Parameters to be monitored	Mitigation measures	Responsible	Monitoring schedule	Monitoring indicators	Monitoring cost (Birr)
Covid 19	Train workers to follow strictly Covid-19 prevention mechanisms Temperature measurement check-up each day at the gate of the compound Provision of materials necessary for prevention and detection of COVID 19	Proponent in collabouration with Woreda health experts	Regularly during construction and operation	Number of Covid-19 infected	Expense already included in construction and operations No cost to report # of cases
Occupational Health and safety	Use of appropriate PPE during installation and maintenance The solar PV plant shall be equipped with a fire-fighting system Ensuring all electrical equipment and machinery are properly grounded;	Proponent	Regularly during construction and operation	Total recorded incidence rates	for provision of first aid a lump sum of 5,000
Fire hazards	The solar PV plant should be equipped with a fire-fighting system The technician should regularly inspect Solar PV components	Proponent	Every three months during the construction and operation phase	Number of incidents and reported cases	Part of project and operation cost
Impacts on historical, cultural heritage	Excavation work should be done carefully as per World Bank Guidelines - OP 4.11 and prepared chance find procedures	Contractor	During construction work	Number of discovered heritage site or artifacts	Part of supervision cost

Grievance redress mechanisms:

It is expected that no major grievance issue will arise. However, to ensure that stakeholders have avenues for redressing their grievances related to any aspect that may result from the project, procedures for the redress of grievances have been established. They are as follows:

The community will be informed about the procedures in their local language. All information about grievance mechanisms will be available in public areas and with the community leaders.

The client/contractor will accept all comments and complaints associated with the project from any stakeholder either in person, via email, post, telephone, or any other appropriate communication channel. The client/contractor will then arrange for an officer to further listen to the complaints then summarize the grievances in a complaints/comments logbook which would contain the name of the commenter, date of receipt, a brief description of the issue, proposed corrective actions, and date of response sent to the complainant.

All grievances will be registered and acknowledged within 6 working days then responded to within 15 days. All responses will be done either in writing or verbally, according to the preferred method of communication of the complainant.

Roles and responsibilities

- Project proponent- manage and monitor the environmental and social impacts
- Environmental Protection agency- is responsible for evaluating and approving ESIA study reports as well as for providing environmental approval licenses
- Environmental protection Agency of the Amhara is expected to be involved in monitoring the environmental performance of the solar power PV project in the region
- Community water use associations/ cooperatives are responsible to oversee fair water sharing among farmers

The estimated overall budget for the implementation of all environmental and social measures, which includes the cost for ESMP and ESMMP, is 835,000 birr or 15,587 USD (assuming 1 USD = 53.6 Birr).

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1. Introduction

1.1. Background of ESIA study

Ethiopia has shown an impressive two digits GDP growth in the last couple of decades. This economic growth brings with it an enormous demand for energy for households and industries. Nevertheless, the country depends largely on hydropower-generated energy to propel its economic growth and provide energy for domestic uses. To meet the rising demands of energy for development and meet the challenges of climate change, Ethiopia designed the Climate Resilient Green Economy strategy (CRGE). This strategy was well aligned with Ethiopia's ambitious plan to become a lower-middle-income country by 2025 (GTP II). The alignment of the two policies (GTP II and CRGE) is instrumental for Ethiopia's broad economic planning and has proven to be particularly central in the design of Ethiopia's power development strategy (Veritas, 2020). The same document stipulates that "Mini grids powered by renewable energy directly address two NDC [Nationally Determined Contribution] components: (i) reduction of greenhouse gas (GHG) emissions and (ii) reduction of the impact of climate change on Ethiopia's population, environment, and economy. Mini grid development also helps to deliver on key CRGE objectives viz: (i) ensuring economic development is sustainable by limiting GHG emissions, (ii) creating green job opportunities, and (iii) protecting the economy and people from the adverse effects of climate change" (Veritas, 2020, p. 7).

Solar-powered mini-grids are favorable for small-scale projects in different regions of Ethiopia namely, Amhara, Oromia, Sidama, and SNNP. According to the Environmental Impact Assessment (EIA) proclamation 299/2002, projects that may likely have adverse environmental and social impacts are required to carry out a full impact assessment. In response, this ESIA has been conducted for the proposed DREAM mini-grid solar power projects. The purpose of the ESIA study is to identify, predict and analyze the nature and magnitude of environmental impacts and propose enhancement and/or mitigation measures for environmental impacts that are likely to arise from the various activities of the project implementation.

In the study process, various ESIA tools were employed for the identification, prediction, and analysis of impacts. To this end, a biophysical resources survey (vegetation, soils, air, and water quality measurements) was conducted to establish baseline conditions, and socioeconomic assessments were carried out. In addition, secondary data sources were consulted to augment field observations and measurements. The assessment followed the national and international guidelines to comply with the best ESIA practices such as, the environmental impact assessment procedural guidelines of Ethiopia and that of AfDBs operational safeguards. The potential positive and negative project impacts have been identified for the construction, operation, and decommissioning phases. On top of this, environmentally sound, socially acceptable impact enhancement and management options were also suggested.

1.2. Objectives of ESIA Study

The main objective of carrying out the Environmental and Social Impact Assessment for the proposed mini-grid solar power plant scheme is, to improve project planning by ensuring that environmental and social considerations are taken care of in all stages of project planning and implementation. These phases include construction, operations, and decommissioning. The ESIA study is particularly aimed at ensuring the environmental and social impacts of the proposed solar mini-grid projects' potential impacts are clearly identified and the corresponding mitigation measures are appropriately addressed before decisions are made to implement the project. Specifically, the ESIA study is to:

Establish the baseline conditions of the project areas.

- Assess and report on the likely magnitude and significance of impacts, both positive and negative
- Conduct stakeholders and community consultations
- Propose mitigation actions to reduce negative impacts and enhancement mechanisms for positive impacts
- Propose ESMP and a monitoring plan for significant impacts.

1.3. Approaches and Methods

1.3.1. General

This ESIA report was conducted between September and October 2021. Data used for the ESIA, were collected from both primary and secondary sources. Primary data were collected through a field survey, expert interviews, and focus group discussions with the communities, while secondary data were obtained from relevant sources: including literature and archives from project area government offices. The assessment process incorporates several key steps and constitutes a systematic approach to evaluating the proposed project in the context of the natural and socio-economic environment of the mini-grid pilot site. In addition, the ESIA team has reviewed compliance with the relevant national and international policies, laws, standards, and guidelines.

1.3.2. Review of relevant documents

Policies, legislation, and guidelines pertinent to environmental and social protections, were reviewed to assess the relevant laws and regulations related to the expected environmental and social impact of the proposed projects. In addition, existing documents on previous studies related to mini-grid solar power plants projects were obtained and reviewed to get insights into important data for the baseline description and background information for the proposed projects (FDRE constitution, 1994; EPA, 1997; CSE, 1997; EPA/EIA, 2002; 2003).

1.3.3. Field Survey

Field surveys and observations are critical to understanding the likely impact of a given project on the environment. The ESIA study team conducted a field survey of the project site in October 2021. The team made observations in and around the project site and gathered essential field data. During site observations information on physical, biological, and socioeconomic environments has been collected. In addition, noise level, air quality, carbon monoxide, and ambient temperature measurements were conducted. Moreover, the team has also collected soil and water samples and subjected them to physio-chemical analysis in the Labouratory to establish baseline conditions.

1.3.4. Stakeholders and community consultations

To elicit the views of stakeholders about the potential impacts and effects of the project stakeholders and public consultations were conducted. The ESIA team followed two stages for public and stakeholder consultations. First, we identified and mapped potential stakeholders (details are provided in section 5.2) based on the nature of the project (e.g., off-grid solar power plant) and the end users or communities. The stakeholders were identified by segmenting across the following groups: directly and indirectly affected persons, institutional stakeholders including government, and organizations likely to be involved in project implementation, regulation, and monitoring.

Following stakeholder identification, we separately engaged the relevant government offices. Official letter communications were made to all the identified government offices and then crucial informant interviews or focus group discussions were conducted as appropriate. For community (public) consultations, we completed a public meeting including all the community members and social influences (e.g., clergy men, and elders) who could potentially be affected by the proposed off-grid solar power plant in the three selected project sites. Local community consultations were conducted in Amharic language (following AfDB's requirement to conduct consultation in a language the communities are comfortable with) at the Telifa locality. The community-level stakeholder engagement activities targeted entire communities within the project's area of influence including the indirect impact zones. Two approaches were adopted at this level, the first was to have general community meetings with the Telifa community and thereafter conduct interviews with representatives such as community leaders and social influencers. During the consultation, the ESIA team disclosed the project and presented the project objectives, the potential benefits, and the adverse impacts. Then, participants were allowed to express their concerns and expectations regarding the project and the likely social and environmental impacts that would likely happen during the construction and operation phases of the mini-grid solar power plant projects.

1.4. ESIA report structure

The ESIA report is structured into 10 chapters. Chapter 1 introduces the project's background, scope, and objectives; whereas Chapter 2 deals with reviews of relevant national policies and strategies, international conventions, lenders guidelines and safeguard standards.

Project descriptions such as proposed project locations, justifications, power, and material requirements presented in Chapter 3. In Chapter 4, details of baseline environmental and social conditions of the proposed project areas are provided. Chapter 5 presents stakeholders' and community consultation findings. Potential environmental and social impacts of the proposed mini-grid solar power plants activities are presented in Chapter 6. This is followed by discussions of project alternatives in Chapter 7. Chapters 8 and 9 present the proposed ESMP and monitoring plans, respectively. In Chapter 10 conclusion and recommendations, based on the findings of the ESIA study, are presented. Finally, references and annexes provided at the end of the report.

1.5. Limitations

The data collected (particularly secondary data) at Kebele and Woreda levels may often be incomplete and fragmented. In some instances, data were not compiled in organized form (e.g., yield per year, land under farming or grazing, etc.). To rectify the constraints and limitations the study team conducted key informant interview with concerned stakeholders and further substantiated them through community consultations.

2. Policy, Legal and Administrative Frameworks

This chapter provides an overview of the relevant legislation, policies, standards, and guidelines applicable to the proposed DREAM mini grid solar power plants and associated irrigation projects. Thus, the chapter reviews applicable national legislations, policies, strategies, and proclamations particularly related to water resources, energy, environmental protections, and others. In addition, the chapter provides a brief discussion of African Development Bank Operational Safeguards which are pertinent to the proposed projects.

2.1. National Laws, Policies and Strategies

2.1.1. The Constitution of Federal Democratic Republic of Ethiopia (FDRE)

The constitution of the Federal Democratic Republic of Ethiopia, Proclamation No. 1/1995 is the supreme law of the land. Article 40 sub-article 3 states that "The right to ownership of rural and urban land, as well as of all natural resources, is exclusively vested in the State and the peoples of Ethiopia. The land is a common property of the Nations, Nationalities, and Peoples of Ethiopia and shall not be subject to sale or other means of exchange."

Article 44 stipulates in sub-article 1 that "All persons have the right to a clean and healthy environment." Sub article 2 of article 44 informs on resettlement action planning. It states that; "All persons who have been displaced or whose livelihoods have been adversely affected as a result of State programs have the right to commensurate monetary or alternative means of compensation, including relocation with adequate State assistance."

Article 36 on the rights of children states that every child has the right not to be subject to exploitative practices, neither to be required nor permitted to perform work that may be hazardous or harmful to his or her education, health, or well-being.

The right of the public and the community to full consultation and participation as well as to the expression of their views in the planning and implementation of Environmental Policies and development projects that affect them is enshrined in the constitution (Articles 92.3 and 43.2).

2.1.2. National Energy Policy of Ethiopia

The Federal government of Ethiopia formulated an energy policy in 1994, which was the first ever comprehensive energy policy in Ethiopia. The main objectives of the policy are

- To provide reliable, timely, and affordable energy to foster the nation's agricultural and industrial development
- To ensure and encourage the gradual shift from traditional energy sources to modern one
- To remove institutional and other bottlenecks for energy development and utilization and streamline the development of indigenous energy sources for self-sufficiency
- To increase energy use efficiency and reduce wastages
- To ensure that the development and utilization of energy are not detrimental to the environment

The policy document has indicated many options for energy development (in chapter 4 of the policy document) to attain the national energy policy objectives. Among them the most relevant for this mini grid solar project are provided below:

- To provide alternative energy sources for the household, industry, agriculture, transport, and others
- To ensure the compatibility of energy resource development which promotes ecological and environmental sustainability
- To facilitate and encourage the participation of the private sector in energy development
- Encourage women's participation in planning, development, and utilization of energy

Even though the energy development plan is heavily reliant on hydropower development other sources of energy are also being considered. The main among them is geothermal, solar, wind, and other energy sources and exploration of fossil fuels (e.g., natural gas), afforestation, and increasing efficiency of agro-residues as sources of energy.

2.1.3. National Conservation Strategy of Ethiopia (CSE, 1997)

The Federal Government of Ethiopia has undertaken several initiatives that aim to develop regional, national, and sectoral strategies to conserve and protect the environment. One of these strategies was the conservation strategy

of Ethiopia (CSE, 1996). This document provides a strategic framework for integrating the environment into new and existing policies, programs, and projects. It is also an important policy document, which views environmental management as an important component of development. It recognizes the importance of incorporating environmental factors into development activities from the outset.

The major environmental and natural resources management issues facing Ethiopia are well documented in the CSE (FDRE, 1997). The CSE sets out detailed strategies and action plans as well as the institutional arrangements required for the implementation of sect oral and cross-sectoral interventions for the management of Ethiopia's natural, man-made and cultural resources.

The most important areas that are addressed by the CSE include the following:

- Management of forest and woodland resources
- Land resource use policy and strategies; physical land-use planning
- Integration of social, cultural, and gender issues in sustainable resources and environmental management
- Promotion of participation in the sustainable development of natural, artificial, and cultural resources, and environmental protection
- Development of environmental education, public awareness, and human resources

2.1.4. Environmental Policy of Ethiopia (1997)

The Environmental Policy of Ethiopia (EPE), was approved by the Council of Ministers in April 1997 (EPA/MEDAC 1997). It is based on the Conservation Strategy of Ethiopia (CSE), developed through a consultation process over the period of 1989-1995. The policy has the broad aim of rectifying previous policy failures and deficiencies, which in the past have led to serious environmental degradation. It is fully integrated and compatible with the overall long-term economic development strategy of the country, known as Agricultural Development Led Industrialization (ADLI), and other key national policies like the National Population Policy and the National Policy on Women.

EPE's overall policy goals, may be summarized in terms of the improvement and enhancement of the health and quality of life of all Ethiopians and the promotion of sustainable social and economic development through the adoption of sound environmental management principles.

Specific policy objectives and key guiding principles are set out clearly in the EPE and expand on various aspects of the overall goal. The policy contains sectoral and cross-sectoral policies and has provisions required for the appropriate implementation of the policy itself.

2.1.5. Ethiopia's Climate Resilient Green Economy (CRGE) Strategy

The Climate Resilient Green Economy (CRGE) is, Ethiopia's overarching framework and a national strategy toward a green economy with the main objective: to protect the country from the adverse effects of climate change and, build a green economy that will help realize Ethiopia's ambition to reach middle-income status before 2025. This strategy was highly synchronized with Ethiopian Growth and Transformation Plan II (2015/2020) which was aimed to bring about structural transformation in Ethiopia's major economic sectors. The objective of the strategy is to identify green economy opportunities that could help Ethiopia reach its ambitious growth targets while keeping greenhouse gas emissions low. The CRGE strategy has identified four pillars: agriculture and forestry, power and industry, transportation, and buildings as instrumental that will support Ethiopia's developing green economy and reach middle-income status by 2025. The CRGE strategy had designed specific objectives to address issues related to water and energy sectors to climate.

These objectives include:

- To identify the economic and social impacts of current climate variability and future climate change on water and energy in Ethiopia
- To identify priority ways that the water and energy sectors can build climate resilience and reduce the impact of climate variability and climate change
- To map the necessary steps to finance and implement measures in the water and energy sectors to build climate resilience in Ethiopia and deliver an integrated climate-resilient green economy

2.1.6. Ethiopian National Energy Policy 2012

Policy objectives concerning environmental impact are in place to ensure the production, delivery, and utilization of energy without affecting or threatening the environment and society. One of the Policy Instruments in this

respect is the introduction of mandatory environmental and social impact assessment on new energy and non-energy investment projects to assess the level of emissions of pollution and determine whether the project will have to be realized and on the type of necessary mitigation measures to be adapted.

2.1.7. National Social Protection Policy of Ethiopia

The main objectives of the Social Protection Policy of Ethiopia are the following:

- Protect poor and vulnerable individuals, households, and communities from the adverse effects of shocks and destitution
- Increase the scope of social insurance
- Increase access to equitable and quality health, education, and social welfare services to build human capital thus breaking the intergenerational transmission of poverty
- Guarantee a minimum level of employment for the long term unemployed and under-employed
- Enhance the social status and progressively realize the social and economic rights of the excluded and marginalized
- Ensure the different levels of society are taking appropriate responsibility for the implementation of social protection policy
- To make practical the above listed objectives social protection policy, the project proponent or developer should abide by the policy prescriptions

2.1.8. Ethiopian Women's Policy

The then transitional government of Ethiopia in 1993 adopted the first National Policy on Ethiopian Women (NPEW). That was the first such move to give an institutional approach to address gender equality and enhance women's development aspirations through policy measures. Indeed, it was a great stride in focus moving away from the welfare approach to that of realization/recognition of women's role and contribution to the national socio-economic development.

The policy has a three-fold objective, the first one is to ensure women's access to basic services such as health, education, and employment opportunities and avoid barriers, such as social norms, and cultural and traditional practices that may hinder women's full participation in the socio-economic development of the nation. Second, the policy gives special attention to eliminating all forms of discrimination against women and creating awareness of women's legal rights. Finally, it was intended to create the appropriate structures within the government offices to establish and monitor the implementation of different gender-sensitive and equitable public policies. Following the policy recommendations of creating an appropriate institutional structure at the various tiers of government, there is now a ministry of Gender and Social Affairs /regional bureaus/district offices of women's and children's affairs.

At the federal level one of the duties and responsibilities of the Ministry of Gender and Social Affairs is, conducting and monitoring gender-related issues and activities at the national level and creating an environment for the implementation of the NPEW in different sectors; (even though the policy needs to be updated to match with the current institutional set up). At regional, zonal, Woreda, and Kebele levels, there are respective offices (at the Kebele level, usually individuals are assigned in place of an office). On the other hand, those situated in line sectors/ministries are mandated to identify issues of gender gaps and develop strategies to address inequalities in the respective line ministries and their sub-sectors. The Gender and Social Affairs Offices are formally accountable to their respective councils, many of which have women's affairs or social affairs committees that are engaged in oversight activities. The plans included steps to enhance rural women's access to and control over productive resources like land, extension, and credit services.

2.1.9. Violence against Women

A declaration on the Elimination of Violence against Women Proclaimed by General Assembly resolution 48/104 of 20 December 1993 is talking about recognizing the urgent need for the universal application to women of the rights and principles concerning equality, security, liberty, integrity, and dignity of all human beings. Under this declaration article 2 states that battering, sexual abuse of female children in the household, dowry-related violence, marital rape, female genital mutilation and other traditional practices harmful to women, non-spousal violence and violence related to exploitation; psychological violence occurring within the general community, including rape, sexual abuse, sexual harassment and intimidation at work, in educational institutions and elsewhere, trafficking in women and forced prostitution; and Physical, sexual and psychological violence

perpetrated or condoned by the State, wherever it occurs. It also stated that women are entitled to the equal enjoyment and protection of all human rights and fundamental freedoms in the political, economic, social, cultural, civil, or any other field.

2.2. National Proclamations

2.2.1. Environmental Impact Assessment Proclamation No.299/2002

This proclamation made Environmental Assessment a mandatory legal prerequisite for the implementation of major development projects, programs, and plans. The proclamation provides a legal base for the effective means of harmonizing and integrating environmental, economic, cultural, and social considerations into the planning and decision-making processes thereby promoting sustainable development. Moreover, it serves as a basic instrument in bringing about administrative transparency and accountability, to involve the public and the communities in the planning and execution of development programs that may affect them and their environment.

2.2.2. Environmental Pollution Control Proclamation No.300/2002 and Industrial Pollution Control Regulation No.159/2008

This proclamation is aimed at eliminating or, when not possible, mitigating pollution as an undesirable consequence of social and economic development activities. It also states that, the protection of the environment and safeguarding of human health, as well as the maintaining of biota and the aesthetic value of nature, are the duty and responsibility of all citizens. It further considers other issues such as control of pollution, management of hazardous waste, chemical and radioactive substances, the importance and need to respect environmental standards, and punitive and incentive measures. The Ethiopian regulatory body such as the former Environment, Forest, and Climate Commission (now reconstituted as Environmental Protection Agency), may make surprise monitoring visits without prior notice, to ensure that the environment is protected from any serious pollution effects.

2.2.3. FDRE Rural Land Administration and Land Use Proclamation No. 456/2005

The Rural Land Administration and Use Proclamation (Proclamation No. 456/2005) provides entitlement to property produced on the land of the occupant, rights of inter-generational transfer, and limited leasing rights. Provisions are made for the registration and certification of tenure rights. Part Three of the Proclamation presents regulations relating to the use of rural land, particularly as it relates to soil and water conservation and watershed management. The rural land administration and land use laws are to be implemented by the regional states. Landholding right gives the right to use the land for agricultural purposes as well as to lease it and, while the right remains in effect, bequeath it to family members.

Article 7 sub-article 3 of the proclamation reinforces the rights of land users to compensation for the development they have made on the land. It also states that when the landholder is evicted by the federal government, the rate of compensation would be determined based on the federal land administration law. When the rural landholder is evicted by regional governments, the rate of compensation would be determined based on the rural land administration laws of regions. It is envisaged that the Proclamation will create a sense of ownership among most of the rural population and enable them to take initiatives and collectively engage in environmental management activities.

2.2.4. Expropriation of Land Holdings for Public Purposes and Payment of Compensation Proclamation No. 1161/2019

The federal proclamation on expropriation of landholding for a public purpose, payments of compensation, and resettlement (Proclamation No.1161/2019) replaced "Expropriation of Landholdings for Public Purposes and Payment of Compensation, Proclamation No. 455/2005". This new proclamation has been formulated to address, *inter alia*, the fast-growing urban population in major cities of Ethiopia and associated land acquisition for residential and infrastructure development needs. Rural areas also define the powers and responsibilities of authorities, which oversee property valuation, payment of compensation, and resettlement. This proclamation was made to correct past misgivings due to gaps seen during the implementation of the previous proclamation 455/2005. Considering these gaps, it envisions providing fair compensation and expedites decision-making for

those whose land has been expropriated for development purposes. Moreover, it envisions putting in place a grievance redress mechanism to address complaints related to land appropriation and compensation. The proclamation states that the landholder whose land has been expropriated shall be paid compensation for the property on the land and the permanent improvement made on the land. The amount of compensation for the property on the land shall cover the cost of replacing the property anew. The proclamation requires compensation and resettlement for land expropriation to sustainably restore and improve the livelihood of displaced people.

2.2.5. Payment of Compensation for Properties Situated on Landholdings Expropriate for Public Purposes (Regulation No.472/2020)

This regulation repealed the Council of Ministers Regulation on Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes (Regulation No. 135/2007). This Regulation contains property valuation and compensation methods and formulae that should be used in calculating compensation for various properties. It also contains lump sum compensation to be paid for severed social relationships and moral damages. The regulation also sets the provision of land expropriation procedure, propriety right to develop the land to be expropriated, provision of substitute of land, housing and resettlement, and shareholder rights of the displaced. This regulation was issued for the purpose of not only paying compensation but also assisting displaced persons to restore their livelihoods. The Council of Ministers Regulation No. 472/2020 was issued to facilitate the proper implementation of proclamation No. 1161/2019.

2.2.6. Labour Proclamation No.1156/2019

The Labour proclamation states requirements regarding employer-employee relationships including requirements for the provision of contracts of employment (Articles 6 & 7) and the need for employers to take all the necessary occupational safety and health measures and to abide by standards and directives to be given by the appropriate authorities in respect to Occupational Safety and Health (OSH) measures.

2.2.7. FDRE federal Civil Servants Proclamation No. 1064/2017

Article 8 states that all positions of equal value shall have equal base salary and any Government office shall, at the end of every month, make payments of salary to civil servants or their legal representatives.

Article 14 presents that civil servant shall not be civil servant:

- A person under the age of 18years
- Any person who has been convicted by a court of competent jurisdiction for offences of corruption, breach of trust, theft, fraud, or rape unless five years have lapsed from the date the penalty is served or is barred by limitation or remitted by pardon
- A person having no certificate of competence
- Any person who is unwilling to take oath of fidelity in accordance with Article 17 of this proclamation

2.2.8. Proclamation for the Establishment of Environmental Protection Organs No. 295/2002

This proclamation established a system that fosters coordinated but differentiated responsibilities among environmental protection agencies at federal and regional levels. It clarifies the mandate and responsibilities of the Federal EPA and the Regional Environmental Authorities (REAs) within the governments of the regional states. The proclamation stipulates that each sector office shall establish an environmental unit to assess and evaluate environmental performance by the sector.

2.2.9. Other strategies and legislations

Other legislation and strategies that may be of relevance to the proposed projects include but are not limited to:

2.2.9.1. Research and Conservation of Cultural Heritage (ARCCH) Proclamation

Proclamation No. 374/2003 (Proclamation to Ratify the Convention on the Means of Prohibiting and Preventing the Illicit Import, Export, and Transfer of Ownership of Cultural Property) requires developers to conduct a cultural resources survey to identify and assess cultural sites that may be affected by the development activities. The Proclamation defines cultural heritage broadly as "anything tangible or intangible which is the product of creativity and Labour of man in the pre-history and history times, that describes and witnesses to the evolution of nature and which has a major value in its scientific, historical, cultural, artistic and handcraft content." Prior approval from the Authority for Research and Conservation of Cultural Heritage (ARCCH) is required to remove immovable

(Article 21/1) and movable cultural heritage (Article 21/2) from its original site, during the execution of the project. Proclamation No. 209/2000 (Research and Conservation of Cultural Heritage Proclamation) allows the use of cultural heritage sites for economic and other purposes if and only if such use is not detrimental to its preservation and does not impair its historical, scientific, and artistic values (Article 22). It specifies that the protection and conservation of cultural heritage is the duty and responsibility of the Authority for Research and Conservation of Cultural Heritage (ARCCH). Proclamation No. 484/2006 (Proclamation to Ratify the Convention for Safeguarding of the Intangible Cultural Heritage) formalizes the adoption of the Convention for the Safeguarding of the Intangible Cultural Heritage in Ethiopia at the General Conference of the United Nations Educational, Scientific and Cultural Organization in Paris on 17 October 2003. The Ethiopian Government ratified the said Convention on 24 January 2006.

2.2.9.2. Hazardous Waste Management and Disposal Control Proclamation No.1090/2018

This Proclamation shall have the following objectives:

- Create a system for the environmentally sound management and disposal of hazardous wastes
- Prevent the damage to the human or animal health, the environment, biodiversity, and property due to the mismanagement of hazardous waste

2.2.9.3. National Health policy

Ethiopia issued its first-ever health sector policy in 1993. The policy was intended to reorganize the health services delivery system to contribute positively to the overall socio-economic development effort of the country. Major aspects of this policy focus on fiscal and political decentralization, expanding the primary health care system, and encouraging partnerships and the participation of non-governmental actors. The policy and other health-related programs of the country highly promote the preventive approach to health services. Hence, the project proponent is also required to act in conformity with this strategy for the occupational health and safety of its workers and the environmental health of the community in the area.

2.2.9.4. National HIV/AIDS Policy 1998

The overall objective of the policy is to provide an enabling environment for the prevention and control of HIV/AIDS in the country.

The specific objectives are:

- To establish effective HIV/AIDS preventive and control strategies to curb the spread of Covid 19
- To promote a broad multi-sectoral response to HIV/AIDS epidemic, coordination of the activities of different sectors, and mobilization of resources for the control of epidemic
- To encourage government sectors, NGOs, and communities to take measures in order to alleviate the social and economic impacts of HIV/AIDS
- To safeguard the human rights of people living with HIV/AIDS
- To empower women, youth, and other vulnerable groups to take action to protect themselves

2.2.9.5. Proclamation for Wildlife Development Conservation and Utilization proclamation 541/2007

This Proclamation has the following major objectives:

- To conserve, manage, develop, and properly utilize the wildlife resources of Ethiopia
- To create conditions necessary for discharging government obligations assumed under treaties regarding the conservation, development, and utilization of wildlife
- To promote wildlife-based tourism and encourage private investment

This proclamation clearly stated that under article 8 no person, other than the Ministry or the concerned regional organ in the discharge of their duties, may hunt any game animal unless he owns hunting permit.

2.2.10. FDRE, Pesticide Registration and Control Proclamation No.674 /2010

The main purpose of this proclamation is to enact comprehensive legislation to regulate the manufacturing, formulation, import, export, transport, storage, distribution, sale, use, and disposal of pesticides and other matters by laying down a scheme of control. These control measures aimed to minimize the adverse effects, that pesticide use might cause to human beings, animals, plants, and the environment. The details on the legislation of pesticides are presented in this proclamation in 37 articles. To mention, article 14 of this proclamation states about pesticides registration and the Ministry (Ministry of Agriculture) shall maintain a separate central database or archive containing the inventory of all pesticides to track the movement and use of pesticides according to each stage of the pesticide life cycle within the country and containing other relevant information, etc.

Article 17 (pesticide import and export permit), in sub-articles 1 and 5, states that no person shall make any import and export of any pesticide without obtaining an import or export permit issued by the Ministry. Similarly, sub-article 3 also states that (a) no pesticide consignment shall be imported if it has been manufactured before six months from its date of entry into the country. Moreover, article 21 (sub-article 1) states that no person shall dispose of any pesticide or pesticide waste in a manner that may harm human or animal health or the environment.

2.3. International Treaties Ratified by Ethiopia

2.3.1. The United Nations Framework Convention on Climate change (UNFCCC), 1992

Article 3(1) of the Convention states that Parties should act to protect the climate system based on "common but differentiated responsibilities", and that developed country Parties should "take the lead" in addressing climate change. Under Article 4, all Parties make general commitments to address climate change through, for example, climate change mitigation and adapting to the impacts of climate change. Ethiopia being a member state of the United Nations, therefore, ratified the convention and must abide by the principles of the convention.

2.3.2. Convention for the Safeguarding of the Intangible Cultural Heritage, 2003

The convention sets out the duties of States Parties in identifying potential sites and their role in protecting and preserving them. Each member country pledges to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage. The States Parties are encouraged to integrate the protection of the cultural and natural heritage into regional planning programs, undertake scientific and technical conservation research and adopt measures that give this heritage a function in the day-to-day life of the community.

2.3.3. International Labour Organization Core Labour Standards

Labour, working conditions, health, and safety are the subject of numerous international agreements, conventions, policies, and standards. Core labour standards formulated by the International labour Organization (ILO) include forced labour, child labour, and workmen's compensation among others.

2.3.4. The Stockholm Convention

This is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms, and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel. In implementing the Convention, Governments will take measures to eliminate or reduce the release of POPs into the environment. Over 150 countries Ethiopia inclusive signed the Convention. Concerning the proposed mini grid solar power plant projects, POPs could arise from open-air combustion of waste, disposal of electronic waste such as used batteries, and degradation of components within the storage.

2.3.5. The Convention on Biological Diversity (CBD)

A major objective of this convention is in-situ and ex-situ conservation of biological diversity. Parties to this convention are required to undertake ESIA for projects likely to have significant adverse effects on biodiversity and are required to develop national plans and programs for the conservation and sustainable use of biodiversity.

2.3.6. African Convention on the Conservation of Nature and Natural Resources-1982

This convention was signed by the Heads of State and Governments of independent African States, assembled at Algiers, Algeria on 15th September 1968. Under this convention in Article II, the contracting States shall undertake

to adopt the measures necessary to ensure the conservation, utilization, and development of soil, water, flora, and faunal resources per scientific principles and with due regard to the best interests of the people.

2.4. African Development Bank Operational Safeguards

The African Development Bank (AfDB) has an Integrated Safeguards System (ISS). The ISS consists of an Integrated Safeguards Policy Statement, Operational Safeguards (OSs), a set of Environmental and Social Assessment Procedures (ESAPs), and Integrated Environmental and Social Impacts Assessment (IESIA) Guidance Notes.

The Bank's Integrated Safeguards Policy Statement sets out the Bank's commitments to and responsibilities for delivering the ISS while Operational Safeguards establish operational parameters, delineates the roles and responsibilities of the Bank and its borrowers or clients in implementing projects, achieving sustainable outcomes, and promoting local participation. Operational Safeguards are also intended to prevent projects from adversely affecting the environment and local communities or, where prevention is not possible, minimize, mitigate and/or compensate for adverse effects and maximize development benefits.

Five Operational Safeguards are established and are summarized here as extracted from the AfDB ISS Policy Statement 2013:

OS 1: Environmental and Social Assessment This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements

> The proposed projects are Category 3 projects as they are less likely to have serious site-specific environmental and/or social impacts. Likely impacts are very few, site-specific, largely reversible, and readily minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards. \
>
> Category 3 investment projects do not require a RAP but may have an ESMP plan to manage and mitigate minor environmental and social risks of projects in compliance with the African Development Bank's safeguards.

OS 2: Involuntary Resettlement: Land Acquisition, Population Displacement, and Compensation This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement, and it incorporates refinements designed to improve the operational effectiveness of those requirements. As the risk category of the project falls under category 3 the project does not trigger OS 2 and hence resettlement action plan and livelihood restorations are not needed.

OS 3: Biodiversity and Ecosystem Services The overarching objective of this safeguard is to conserve biological diversity and promote the sustainable use of natural resources. This safeguard could be triggered due to trade-offs of ecosystem services where the availability of solar energy may result in increased withdrawal of water for irrigation (increase production) at the cost of regulatory services such as draining wetlands which are carbon sinks and biodiversity hotspots.

OS 4: Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials, and Resource Efficiency This safeguard covers the range of impacts of pollution, waste, and hazardous materials for which there are agreed on international conventions and comprehensive industry-specific standards that other multilateral development banks follow. The solar mini grids power plants are meant to curb pollution which is already underway through diesel pumps for irrigation. These operational safeguards are triggered because irrigation activities, especially the use of pesticides, may result in water and air pollution. It is noted that pesticide-related activities are pre-existing within the baseline of farmer activities at these sites. Irrigation activities, especially the use of pesticides will result in air pollution.

OS 5: Labour Conditions, Health, and Safety This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights, and protection from abuse or exploitation. It covers working conditions, workers' organizations, occupational health and safety, and avoidance of child or forced Labour.

2.5. Institutional Framework

2.5.1. Institutional Arrangements for Environmental Protection

The definition of powers and duties of the executive organs of the Ethiopian Environmental Protection Authority (EPA) was established by proclamation 295/2002. The EPA has been subsumed under the former Environment, Forest & Climate Change Commission until 2021. However, recently the commission was dissolved and renamed

EPA, where the forest sector was merged into the Ministry of Agriculture. The objective of the newly re-established Environmental Protection Authority is to formulate policies, strategies, laws, and standards which foster social and economic development in a manner that enhances the welfare of humans and the safety of the environment and to spearhead ensuring the effectiveness of the process of their implementation.

Part three of Proclamation No. 295/2002 states that every competent agency shall establish or designate an environmental unit that shall be responsible for coordination and follow-up so that the activities of the competent agency are in harmony with the proclamation and other environmental protection requirements. Each national regional state is also required to establish an independent regional environmental agency or designate an existing agency for coordinating the formulation, implementation review, and revision of regional conservation strategies and environmental monitoring, protection, and regulation.

2.5.2. Environmental Protection Authority of Ethiopia (EPA)

The former Environment, Forest, and Climate Change Commission (EFCCC) are now renamed as Environmental Protection Authority. This federal institution is entrusted with managing the Environment of Ethiopia. The EPA is responsible to ensure the realization of the environmental rights, goals, objectives, and basic principles enshrined in the Constitution. As well as the Environment Policy of Ethiopia through coordinating appropriate measures, establishing systems, and developing programs and mechanisms for the welfare of humans and the safety of the environment.

It is mandated to formulate or initiate and coordinate the formulation of strategies, policies, laws, and standards as well as procedures and upon approval monitor and enforce their implementation. It is also responsible for the synergistic implementation and follow-up of international and regional environmental agreements. EPA is mandated to review, approve ESIA reports and issue the environmental authorization. The EPA also undertakes the role of certification of ESIA practitioners.

2.6. Regional Government Offices

The regional governments based on the constitution of the federal republic of Ethiopia established relevant executive organs. The following executive organs will be relevant for the proposed project.

2.6.1. Amhara Bureau of Agriculture

The Amhara region bureau of agriculture has a wide range of duties to improve agriculture activities in the Region. The most relevant to the proposed project include the following:

Provides agricultural training and extension services. They are responsible for agronomic issues and agriculture conservation practices that improve agronomic practices in the proposed project area such as crop rotation, intercropping, land preparation, planting method, and planting materials

Provides agriculture information and extension services to the community as well as supports training and scaling up best practices to all farmers. For such cases, a farmer's training center (FTC) is mandated to train farmers on different agricultural technologies

Administers land resources of the region and prepares land use plan

Encourages farmers to undertake crop protection to control crop damage or yield reduction caused by insects, diseases, weeds, and other destructive animals

Follows up the implementation of recommended fertilizer and time of fertilizer application for the proposed crops of this project

2.6.2. Amhara Bureau of Water, Irrigation, and Energy

The Bureau of Water, Irrigation and Energy Development was established as the Bureau of Water, Minerals and Energy Resources Development in accordance with Proclamation No. 4/1988 of the Amhara National Regional State Council. The bureau is entitled to a wide range of duties related to irrigation activities in the region. The most relevant to the proposed activities include:

Assign irrigation experts in the project area to advise and assist irrigation users

Provide training for irrigation users for the wise use of the water resource

Form and follow irrigation water user associations to facilitate and manage fair distribution of waters for irrigation

2.6.3. The Amhara Environmental Protection Authority

The Amhara Environmental Authority acts as a regional environmental regulator (with its respective offices at lower levels) and is responsible for the following activities:

Reviewing or evaluating the ESIA documents prepared by the consultant of the proponent. Based on the assessment results, the authority sets the overall direction for a project's environmental performance

Enforces and guides land compensation payment issues as per land proclamation and rules

Regulates and follows up that any development shall conduct ESIA prior to the project implementation

Undertakes environmental auditing of establishments for the safe disposal and management of liquid and toxic wastes

3. Project Description

3.1. Project location

The project site is in the south Gondar zone, Amhara regional state. The proposed site is found at Fogera Woreda (Telifa locality) (Figure 1) and can be accessed through the Bahirdar-- Gondar asphalted road. Telifa site is located 14km west of Wereta town (Figure 1) The road from Hamusit to Wereta is a 35 km asphalted. From Wereta to Ehud Gebaya is 12km all-weather road, the remaining 2km to Telifa site is only accessible during the dry season.

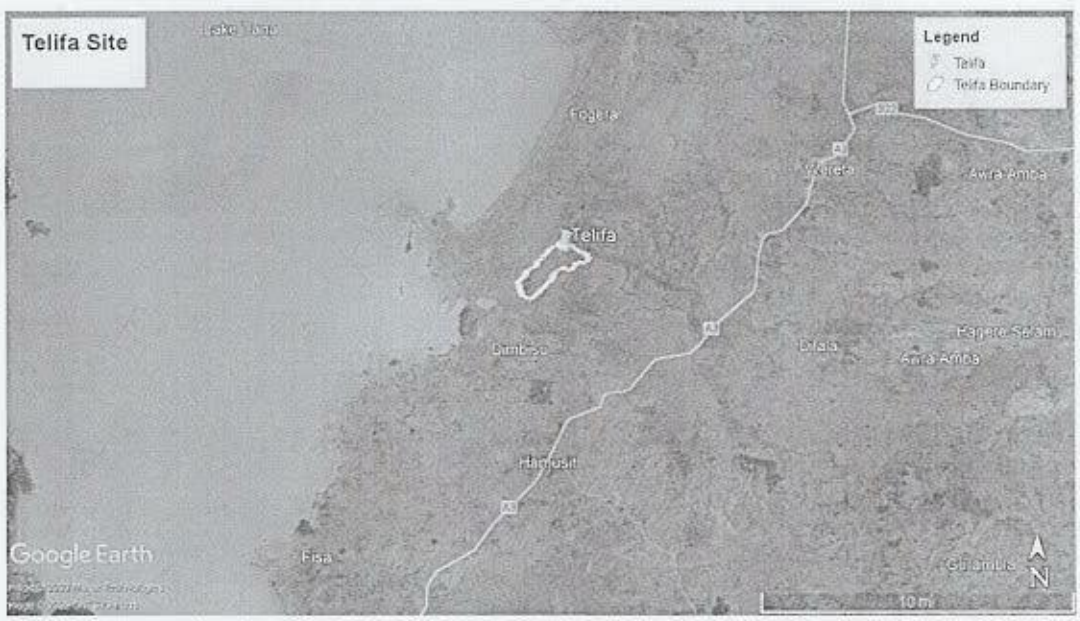

Figure 1 Location map of Telifa

3.2. Project justifications

Solar mini-grids are proven to be more environmentally friendly compared to other sources of energy and other types of power generation projects. The importance of renewable energy, including solar power technology, is also highlighted in the national Growth and Transformation Plan (GTP) II and is compliant with Ethiopia's Climate Resilient Green Economy Strategy (CRGE). The purpose of the planned solar mini-grid project is mainly to substitute diesel irrigation pumps with electric-powered irrigation, which would intensify the existing irrigation activities at the project site. Consequently, farmers will have access to reliable water which would help them increase agricultural production/productivity, ensure food security, and help to mitigate and adapt to climate change. In addition, the households, social institutions, and businesses in the community will also get access to electricity.

3.3. Project components

The major project components are discussed hereunder. However, this section is expected to be revised and updated once the project feasibility report is completed.

Mounting system: PV modules will be mounted on structures made of aluminum or hot-dip galvanized steel. Footing design and type will be decided during design work.

PV Modules: PV modules absorb the sun's rays as a source of energy to generate electricity.

Inverters: Inverters convert the Direct Currents (DC) produced by PV modules to grid-exploitable Alternative Currents (AC).

Battery: lead acid batteries will be used as energy storage device to provide electricity during nighttime and periods of low solar irradiation. Determining battery capacity depends on the required consumption of energy during nighttime and choice of such technology will be under the discretion of developers.

Transformers: Transformers will change voltage levels from low voltage (230V) to medium voltage (15kV or 33kV) and vice versa.

Distribution grid: overhead distribution lines mounted on wooden poles will be used to transfer power from the solar power plant to households, businesses, and irrigation pump customers.

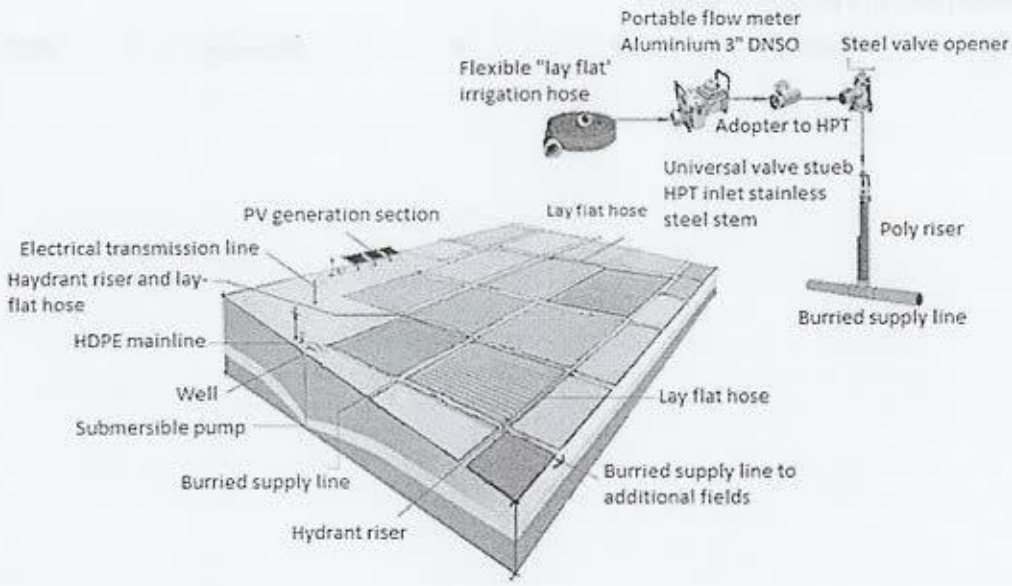

Figure 2 Irrigation Scheme Design

3.4. Civil works

Civil works related to the solar PV construction will include land excavation and leveling, foundations for the installation of the mounting system for the PV modules, the building of access roads and fencing, as well as the construction of the light buildings (operation and administration building, security posts, storage, etc). The project intends to use the existing irrigation canal at the Telifa site and there will not be any irrigation canal development at the other two sites.

3.5. Manpower requirements

Installation of solar PVs, and installation of distribution grids are Labour intensive works during the construction phase and are expected to hire 150 skilled and 75 non-skilled workers. However, during the implementation phase, manpower requirement is minimal, it is expected to create jobs for 5-7 per site and a total of about 20 jobs will be created. Similarly, during the decommissioning phase, about 6 skilled manpower and about 50 Labourers per site are required to dismantle solar panels and other equipment.

The non- skilled workers should be hired from the nearby communities and some skilled manpower may come from other parts of the country and will rent houses in the nearby towns. Therefore, there is no need to construct camps during construction or house for temporary workers. During the construction phase, construction machinery such as an excavator, dump trucks, a mixer and Rollers will be used.

3.6. Land requirement

The land required for Solar PV modules installations is 0.69 hectares for the Telifa site. The total area required, including internal roads, and light buildings, are estimated to be 0.828 hectares.

The area stated was calculated based on an assumption of 12 sqm per kW.

3.7. Implementation schedule

Following submission of the final ESIA report, the major activities are tentatively scheduled as follows:

- CConstruction starts in July 2023
- Construction lasts for 6 months for Minigrid
- Operation will start in December 2023

4. Baseline Information for the Proposed Project Sites

Conducting a baseline survey before the commencement of a project is important to understand the socio-environmental situation of the target area very well and to plan where to focus. Therefore, a baseline survey is conducted through interviews, stakeholders and community consultations, and expert field surveys and the results are summarized in the following sub-sections.

4.1. Physical and biological Baseline Information

4.1.1. Climate: temperature and rainfall

The Lake Tana basin is characterized by bimodal rainfall distribution with a main rainy season from June to October and a small rainy season from February to March (Asmare et al., 2020). The long-term (1951–2013) average rainfall of Bahir Dar, Debre Tabor, and Gondar meteorological stations ranges from 680 to 2400 mm (Lemma et al., 2017). The mean annual rainfall (2006–2013) 1250–1500 mm in the east where the current project site is located (Lemma et al. 2017), while the air temperature varies between 12 and 28°C in Bahir Dar and 9–24°C in Debre Tabor. In situ measurement of temperature in the field from 06/10-09/102021 was in the range of 26-27 for Telifa site.

4.1.2. Geology

In general the proposed project site is a volcanic rock of tertiary and lake shore unconsolidated recent alluvial-lacustrine deposits of quaternary age. The tertiary volcanics are found in the highlands to the east, south, and north of the proposed site while the recent quaternary alluvial lacustrine, volcanic, and pyro clasts are found within the specific site of Telifa. There is no rock outcrop in the Telifa area due to alluvial deposition and thick soil due to long periods of weathering hence the site lacks any significant materials for the identification of parent materials from which the soils were formed.

4.1.3. Topography and drainage

The project area lies to the southeastern fringe of Lake Tana. The topography of the target area is part of the Fogera plain (Figure 3)Telifa site is monotonously flat. The maximum and the minimum elevation in the project areas are 1970m and 1790m above mean sea level at the southeast of the project areas and Telifa target, respectively (Figure 3). Field measurements of elevation using GPS at Telifa is 1800m. Flat land is used for cultivation and animals grazing. Gumera River is a Perennial River that crosses Telifa. This river is used for irrigation as well as for domestic uses and fishing. The stream originates from the Gunna mountains and drain towards L. Tana.

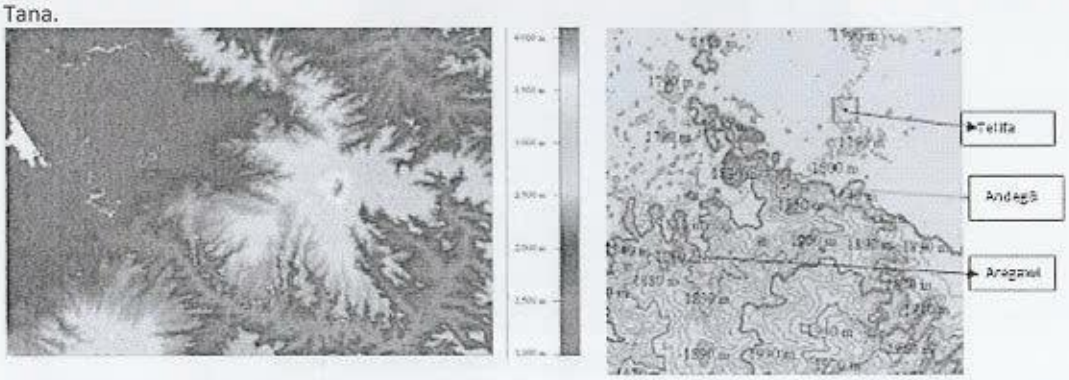

FIGURE 3 PARTIAL VIEW OF THE TOPOGRAPHIC FEATURES OF THE PROJECT AREAS

4.1.4. Soils

The soil in the area is a weathered alluvial lacustrine sediment and quaternary and tertiary volcanic as well as organic humus. Soils are largely reddish brown to dark in color with large content of clay due to the deposition of fine soil particles from the highlands (

FIGURE 4). The soil sample is taken from Telifa project site with sample number TSS-001. The topsoil samples (20-30cm depth) are taken from cultivated and wetland parts of the area. Soil samples are taken for Labouratory to characterize the physical and chemical characteristics at Ethiopian construction and design supervision works Corporation Labouratory in Addis Ababa. The Labouratory result is presented in Annex 4. The results of pH, macronutrients (Phosphorus, Sulfur, Potassium, Sodium, Calcium and Magnesium) and micronutrients (Iron, Manganese, Zinc and Copper) are indicated in detail in the annex. The pH value of the soil in the site is 6.28 which suggests the soil in the area is slightly acidic. The Labouratory results of the micronutrients for Fe, Mn, Cu and Zn are reported to be 51.4 mg/kg, 39.17 mg/kg, 2.03 mg/kg and 1.21mg/kg, respectively. Plant nutritional reference values for iron 20-30mg/kg, 20-3000 mg/kg for manganese, 15 to 40 mg/kg for copper and 25 to 200mg/kg for zinc.

When we compare the reference value with the Labouratory results the soil content of Fe is higher than the appropriate normal value whereas the soil content of Cu and Zn appear to be low (Annex 4). Similarly, the reference value of Na in soil should be less than 180mg/kg but the Labouratory result revealed that the value of Na is 0.09meq/100g of soil or 200mg/kg. The Labouratory result indicates that the value of sodium is greater than the normal value of sodium in the soil and the soil may require treatment. Similarly, the Labouratory results of Mg and K are greater than the expected normal values in soil.

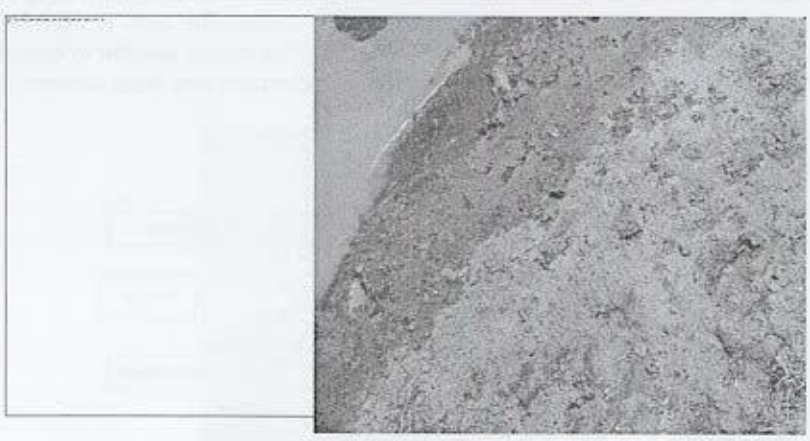

FIGURE 4 SOIL SAMPLING SITES (LEFT) AND SOIL PROFILE (RIGHT) AT TELIFA

4.1.5. Water Resources

4.1.5.1. SURFACE WATER RESOURCES

The major river in the project area is Gumera river Fig.5). Gumera is the major river that flows east to west and finally joins Lake Tana. It is a perennial river flowing throughout the year and has about a 50-meter width. Telifa site residents use this river both for irrigation and domestic use. There are seasonal streams with dendritic patterns joining Gumera.

Water quality investigations were conducted during the ESIA baseline studies. Analysis of samples indicates that the surface water sources have detectable issues of water quality such as turbidity and manganese for Telifa site. The water sample was taken from Gumera River which is being used as a source of drinking water and irrigation in Telifa village (Table 1). All other details of Labouratory tests are presented in Annex.

Table 1: Selected Parameters Of Water Quality Tests For Telifa Site

No	parameters	Unit	Telifa	WHO maximum limit	Remark
1	Turbidity	NTU	181	5	
2	EC	uS/cm	85.4	2000	
3	PH	log10	7.09	6.5- 8.5	Unacceptable
4	TDS	ppm	42.6	1000	
5	Nitrate, NO3	mg/l	0.26	10	
6	Total hardness	mg/l CaCo3	70	300	
7	Manganese	mg/l	0.14	0.1	Unacceptable

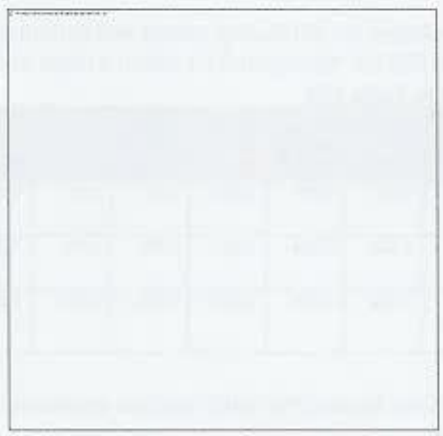

FIGURE 5 GUMERA RIVER

4.1.5.2. GROUND WATER

The groundwater potential appears to be high in the project area. Interviews with the local communities and woreda level experts reported that in Telifa, groundwater levels range from 8 to 10 meters. Fogera Woreda largely depends on the groundwater sources for domestic and irrigation water supply. As information obtained from the woreda water office, the discharge capacity of deep wells varies from place-to-place ranging from 8 lit/ sec to 30 lit/sec. The depth of deep wells drilled for drinking water for the communities' ranges from 130 to 408 m.

4.1.6. Noise baseline condition

During the construction phase, some noises could be generated by construction machinery (like excavators, loaders, bulldozers, mixers, dump trucks, compactors, generators, etc) movements. This may disturb the workers of the project and the nearby villagers to some extent. Accordingly, at each site two locations were selected; settlement area (considered as sensitive receptors) and actual project area (irrigation/farm area). Noise by nature is a nuisance and may bring about annoyance, sleep disturbance, and interference with communication and cause ear disease if the level is beyond the acceptable limit (WHO prescribes 55dB for residential areas). However, the construction noise will last for a short period and is not expected to cause a significant nuisance to the public, at least not with standard mitigation measures in place (see Table 2- Table 3) for baseline conditions).

Table 2: Noises And Temperature Measurement Results Of Telifa Site

Site	Location UTM	Elevation in meters	C0	Noise in dB			Time	Date
				Max	Min	Av		
Telifa	344614E 1313328N	1800	27	67.2	40.5	53.8	12:10	5/10/2021
Telifa	344723 E 1313067N	1796	26	67.7	46.4	57	1:05	5/10/2021
Telifa	345210E 1313197N	1805	27	95	38.2	66.6	12:40	5/10/2021

4.1.7. Baseline air condition

Ambient air quality measurements are essential to provide a description of the existing conditions, to provide a baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed project on air quality conditions. Accordingly, two locations were selected at the site: (1) settlement area (considered as sensitive receptors) and (2) actual project area (irrigation/farm area) Figure 6. Air pollution is one of the serious environmental and social problems which create several adverse effects on human health due to their nature and residence time in the atmosphere. In addition to their negative effect on human health, they exert a strong effect on local and global climate change. Air pollution is often intensified in connection with development activities such as agriculture (irrigation) and industry. Hence, the source of air pollution and its mitigation measures should be understood and analyzed in advance of the commencement of any project development and implementation.

Air quality baseline measurement was conducted for particulate matter and carbon monoxide for Telifa (Table 3). Particulate matter concentration is below 0.075 (75 microgram/L) is within a range of recommended good quality.

Table 3: Air Quality Measurement Results At Telifa Site

Site	Location UTM	Elevation in m	Unit	CO	PM2.5			Pm10			Time	Date
					Min	Max	Av	Min	Max	Av		
Telifa	344614E 1313328N	1800	ppm	0	0.003	0.005	0.004	0.002	0.19	0.009	12:15	5/10/2021
Telifa	344723E 1313067N	1796	ppm	0	0.001	0.003	0.002	0.002	0.005	0.0035	12;45	5/10/2021
Telifa church	344309E 1313572N	1803	ppm	0	0.002	0.018	0.008	0.003	0.023	0.014	10:00	6/10/2021

PM2.5 ranges from 0.002 to 0.032, which is not beyond the WHO required standards. Moreover, CO concentration was nil in the proposed three sites (Table 3).

In summary, the implementation of the proposed solar power plant for irrigation and electrification does not involve any release of greenhouse gases (GHG). Rather it is expected to offset or avoid minor emissions from diesel pumps. Nonetheless, chemical effluents due to irrigation activities especially during aerial spray of pesticides will have localized pollution impact. This impact is very much localized and can be managed to mitigate its effects on human health.

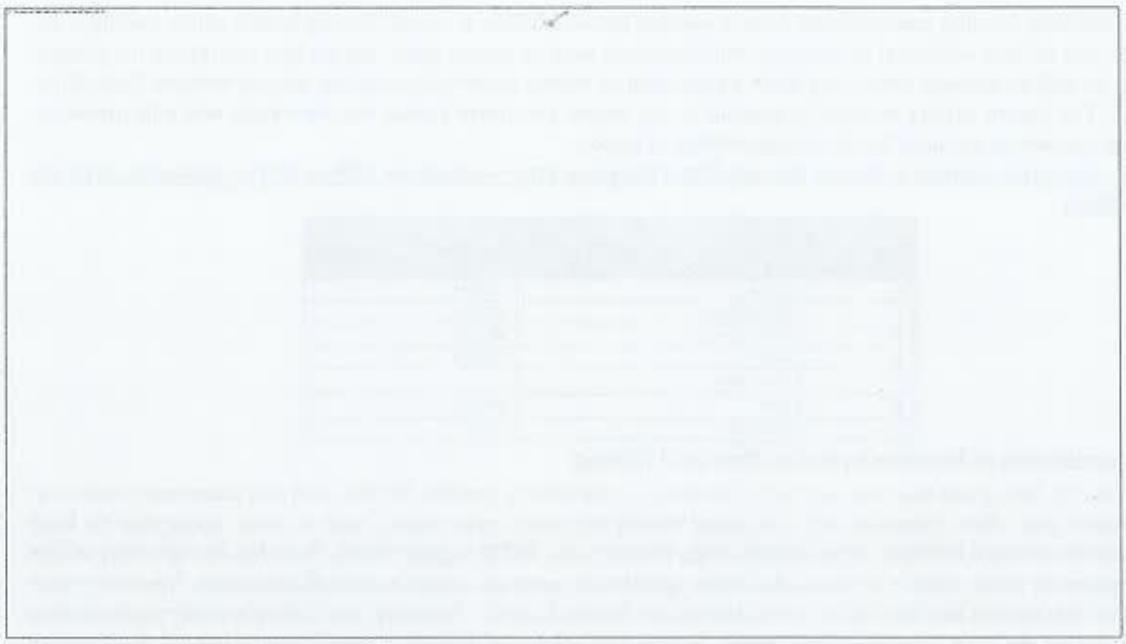

Figure 6 Noise And Air Quality Sample Collection Points For Telifa

4.1.8. Flora

4.1.8.1. TELIFA SITE

The area is a non-forested. Trees are scarcely grown within and around farmlands, and homesteads. Indigenous trees such as Cordia africana, *Juniperus* procera, Croton macrostachyus and *Vachellia sp.* were seen in the area but Eucalyptus tree is commonly found around the villages. Since Telifa is characterized by plainly swamp land, bushes and scrubs are rare except Senna didymobotrya along roadsides Figure 7. Although different types of crops are grown in the area, the main ones include rice, Garlic (Allium sativum), maize (Maya zeas), Teff (Eragrostis teff), and chickpeas (Cicer arietinum).

Figure 7 Commonly Found Busu (Senna Sp.) At Telifa

4.1.9. Fauna

4.1.9.1. DOMESTIC ANIMAL

As any highland farming communities, Fogera woreda farmers follow a mixed farming where cattle rearing is an integral part of farm activities. In addition, small livestock such as sheep, goat, and poultry are reared for protein sources as well as markets since they fetch a good deal of money from the increasing market demand from Bahir Dar city. The Fogera variety of cattle is peculiar to the region and much known for their meat and milk products. Donkeys and horses are used for the transportation of goods.

Table 4: Domestic Animals In Fogera Woreda (Data Obtained From Agriculture Offices Of The Woreda), 2013 E.C (2020/2021)

	Domestic animals	Woreda Fogera
1	Cattle	322854
2	Sheep & Goat	129811
3	Pack animals	34,233
4	Hen	221379
5	Bee colony	-
6	Fish	802.607
7	Red- fish	914

Main problems in livestock production and fishing

Livestock and fishing are the main sources of livelihood and dietary protein for the rural and urban populations in the project area. Fish, however, are consumed mainly by urban populations than in rural areas due to food traditions in northern Ethiopia. Some studies (e.g., Amare et al., 2018) suggest that L. Tana has low diversity of fish as compared to other lakes in Ethiopia, but some species are quite abundant in their distributions. The three most abundant fish species are Nile tilapia and Labeobarbus spp and catfish. Recently, the fishery is under pressure due to overfishing by ever increasing population around the Lake and habitat degradation owing to the invasive species, Eichhornia crassipes.

Regarding livestock resources, Fogera variety is well known for its milk and meat products. But recently the Fogera cattle breed is decreasing due to the following reasons.

Tsetse fly causing animal mortality (particularly from August to October)

Increased level of hybridization with other stocks (genetic dilution).

Lack of feed and forage for the animals hence people tend to opt for small livestock.

Waterborne diseases such as Liver worms and others

Imported net from Sudan catches very small fishes and dwindled fish stock

Herbicides used in a farming area causes fish deaths

Telifa site water will be extracted from Gumera river such extraction of water may affect riverine fisheries and fish resources. Eichhornia crassipes (Emboch) is another problem to the productivity of fish

4.1.9.2. WILD ANIMALS

Only foxes and birds were seen in Telifa site during ESIA team field visits Figure 8

Figure 8 Some Birds Observed In Telifa Site

4.2. Socio-Economic Baseline Information

4.2.1. Population

Based on the 2007 Central Statistical Agency (CSA) report, Fogera Woreda has a density of 206 people per km2. The population in the target kebele of Wagetera (Telifa site) is densely populated and lives in closely packed nucleated village houses. Almost all the houses are built of Eucalyptus poles and mud, with a ceiling of corrugated iron sheet.

The population of the Wagetera kebele (Telifa site), is presented in Table 5 below. All the people in the project site are farmers. The total population is over 13,895 (Table 5). There are 2439 households out of which around 14% are female headed (Table 5).

Table 5: Population And Cultivated Lands In Wagetera Kebele

Kebele	Population	Total House holds	Female headed household	Cultivated land (ha)	Irrigation participant	
					Men	Women
Wagtera	13895	2439	340	1,688	-	-

4.2.2. Agriculture activities

Land use is largely dominated by cereal crops. Traditionally the most important cereals were teff, and maize FIGURE 9. This has, however, changed in the last two decades with the advent of rice. Rice has overtaken the primacy because of the availability of paddy fields in Fogera plains. Nonetheless, increased incidences of crop diseases (common rust and bacterial wilt) particularly for rice have withheld the potential of it to secure farm households'

food security. ESIA team probed questions to agriculture office experts and the local communities on the challenges during farming and harvest seasons. The experts reported that farmers' low capacity to absorb new technologies such as new crop varieties, fertilizer uses, land degradation, and climate change as the main challenges. Whereas the farmers mentioned that prices for fertilizers, lack market for their products, shortage of manpower during harvesting, post-harvest loss due to rodents, etc.

FIGURE 9 MAJOR CROPS GROWN DURING THE SUMMER SEASON IN THE PROJECT AREA

4.2.3. Health Facilities

Malaria falciparum and respiratory infections are the two causes of morbidity in Fogera Woreda in FIGURE 10

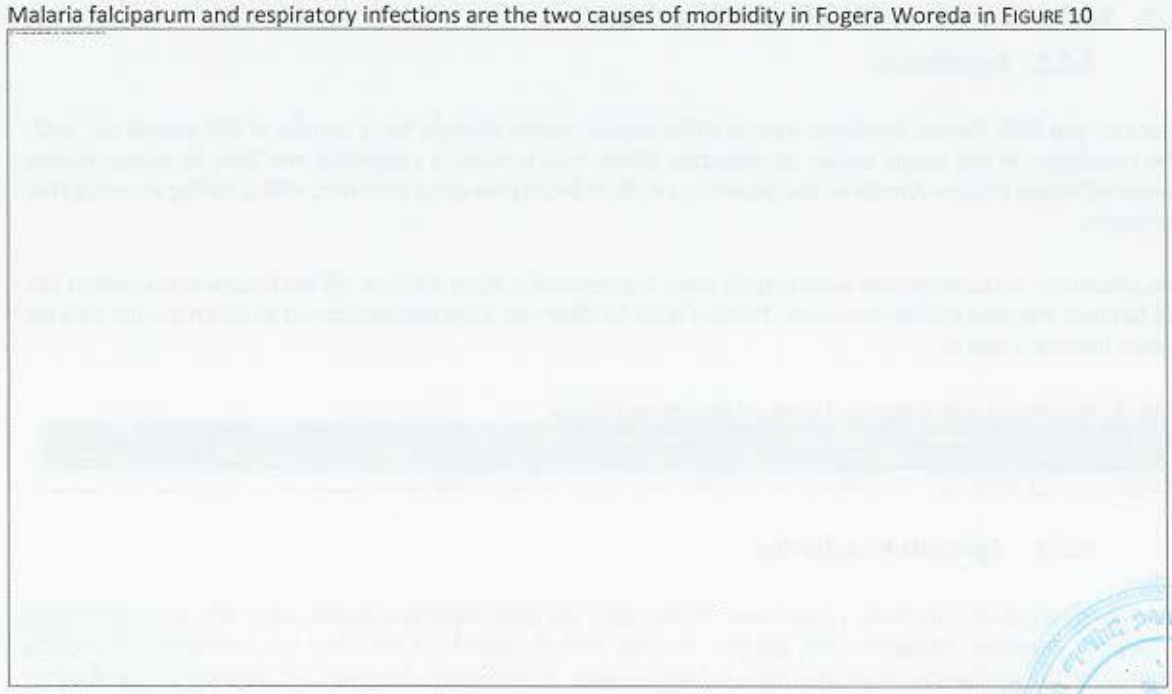

FIGURE 10 TOP TEN DISEASES IN A NUMBER OF PEOPLE AFFECTED IN FOGERA WOREDA

As most people during the ESIA study informed us that health centers are located far from Telifa village and there are no good road networks to reach them. Thus, people carry sick people with "Hosansa" to reach the nearest health center (2.8 Km) (FIGURE 10). The available health centers are also poorly staffed and lack medical equipment and medicines.

4.2.4. Education

Regarding education services, access is quite good for the primary level (Grades 1-8). For example, primary level education coverage is 90.48% whereas it was only 33.81% secondary (Grade 9-12) (Table 6).

Table 6: Number Of Schools And Students In Fogera Woreda (June 2020 To June 2021)

SN	Level of school	Fogera	
		No of student	Coverage
1	Prim (1-8)	56048	90.48%
2	Sec (9-12)	8440	33.81%

4.2.5. Electric supply

The main grid power supply is accessible for few who are located along the medium voltage transmission lines. ESIA team learned that the woreda administrations were planning to invest in alternative sources such as biogas from *Eichhornia crassipes*, solar energy, etc.

Similarly, information obtained from Fogera Woreda Water and Energy resources development office, there is no solar energy application for water abstraction for irrigation purposes in Fogera Woreda. However, consultation with local people has shown that there are about 16 shallow wells that use solar electricity to withdraw water and some households are using solar power lights and mobile charging. There is an estimated number of 45 households that are currently using solar energy with the support of the government and individual farmers' initiatives.

4.2.6. Road Infrastructure

Road network is poor in Fogera Woreda. The only asphalted road is Bahir Dar Gondar highway. The road to the Wagetera kebele is also poorly maintained and it takes more than an hour drive to cover 20km from the main Bahir Dar-Gondar highway. However, from the kebele center to reach the Telifa project site one must walk about 2.8 km on foot. Maintenance is difficult and costly due to the rugged topography and swampy nature of the landscape (Figure 11) During dry seasons (November to May), however, all sites can easily be accessed by road.

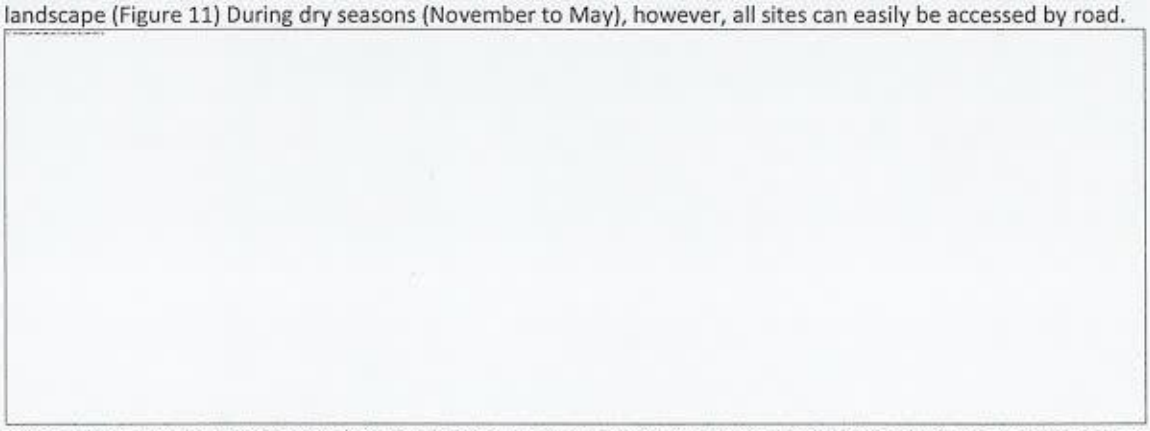

Figure 11 The local people including the field team accessing telifa site on foot due to lack of road vehicles and sick person carried by Hassansa

4.2.7. Utility Service

Mobile telephone and 4G network services are available in most parts of Fogera Woreda. These services are available in Wagetera kebele (Telifa locality). People can, therefore, easily communicate from within the project area through email, telegram, WhatsApp, etc, as well as on phone calls using smart mobile. Bank, Fuel stations,

Postal offices, hotels, Supermarkets, and other shopping services are available in the nearest towns such as Hamusit, Wereta, or Bahir-Dar.

4.2.8. Physical cultural, religious, and archaeological resources

Churches and monasteries are the most common religion-related heritages in Amhara Region. There are several churches and monasteries in Fogera Woreda (Table 7). Some of the notable cultural sites are documented by the culture and tourism offices (Table 7). Most of these are found outside the potential irrigation areas and solar power plant will provide them with a potential source of power.

Table 7: Historical And Cultural Sites In Fogera Woreda

SNo	Tourist attracting historical and natural places Fogera Woreda
1	Shersher Fogera Wetland
2	Awerabiba Society
3	Cultural using & Drinking Materials
4	Amoragedel
5	Cultural Dresses and Jewelry
6	Saint Christos semra Monastery
7	Shimela Bird
8	Emperor Susenyos Army Camp

4.2.9. Gender Equality

Gender relationship has always been dominated by men in rural Ethiopia, an especially productive asset such as land and oxen are owned by men but animal products such as dairy products are owned by women. The main sources of income for the families are agriculture both irrigation and rainfed. According to locals, poor people are defined as those people who have no fixed assets such as farmland. According to our discussion with the local people in the proposed Telifa area, widow or divorced women are more vulnerable to poverty compared to men-headed households. Poor people in the locality have community-based social support such as the contribution of a small number of grains from each household, lineage, and family support. Malnutrition is prevalent and poor people especially women and children are the most vulnerable ones.

5. Public Consultations and Stakeholder's Engagements

5.1. Objective of stakeholder consultation

Public consultation and stakeholders' engagement are crucial components of environmental and social impact assessment. Such efforts are believed to provide opportunities for people who are potentially affected by the intended solar power plant projects to contribute and improve the design and implementation of the project activities. In addition, public consultation will enable project proponents to identify or mitigate any potential adverse impact that might arise due to project implementations. Furthermore, public consultation ensures the enhancement of positive impacts of projects and contributes towards sustainable development of the target area and beyond.

A stakeholder is defined as "any individual or group who is potentially affected by the proposed initiative or can themselves affect the proposed initiative". Stakeholder engagement is a crucial component of environmental and social impact assessment.

The main objectives of public consultations and stakeholder engagement are to:

- **Identify**: all those affected by or interested in the project to ensure that they are included in the engagement process.
- **Understand**: the views of the key stakeholders and make sure that stakeholders adequately understand the positive and negative impacts of the Project
- **Inform**: the ESIA, including local benefits and partner opportunities
- **Relationships and Trust**: build relationships through supporting open dialogue and engagement with stakeholders. Establish transparency in activities being undertaken and build trust with stakeholders
- **Engage with all Stakeholders**: by having an inclusive approach to consultation and participation. This may include the use of differential measures to maximize the effective participation of stakeholders that might not be easily reached through conventional methods
- **Manage Expectations and Concerns**: by providing a mechanism for stakeholders to engage with the project about their concerns and expectations and provide a mechanism for receiving, documenting, and addressing comments received
- **Compliance**: with both national regulations and international best practice

Project details were disclosed to all stakeholders and the host community. The team also undertook to consult with administrative stakeholders to identify their views on the proposed project and perceived impacts.

5.2. Stakeholders Mapping and Analysis

The ESIA is considered to have engagement with the community directly affected and indirectly affected persons and institutional stakeholders including government and organizations likely to be involved in project implementation, regulation, and monitoring.

A list of stakeholders consulted to date is included in Table 10. The input from stakeholders obtained during the ESIA has informed the identification of important issues and potential sensitivities that merit further stakeholder engagement.

Table 8: Stakeholders Identified, Their Roles And Status Of Consultation In The Amhara Region

Stakeholder	Role and Interest/ Influence	Status of consultation	Outcomes of consultations
Amhara region water, mine, and energy office	Regional government	Letter sent, meeting conducted to introduce the project and project team.	Project disclosure was made, data and information were collected
Fogera woreda Water, Mine and Energy Office	Local governments	Letter sent from the zone and meeting was conducted to introduce the project and project team.	Project disclosure was made, data and information were collected
Community from Telifa village	Host community, all have interest in power for domestic consumption and irrigation and some have an interest in new employment opportunities	Meetings were conducted to disclose the project to community	PAPs may be identified later when the exact location of the project is known, and the developer identified
Fogera Woreda Culture and tourism offices	Local governments	Meetings were conducted to disclose the project and identify any known cultural and archaeological sites in the proposed project area	Discussions were made, data were obtained regarding culture and tourism sites
Fogera Woreda Agriculture and Natural Resources Offices	Local governments	Letter sent, meetings were held to introduce project and request data	Project disclosure was made, data were obtained

5.3. Outcomes from Community and major institutional stakeholders' consultations

5.3.1. Community consultation at Telifa site

For community (public) consultations, we conducted a public meeting including all the community members and social influencers (e.g., clergymen and elders) who could potentially affect or be affected by the proposed off-grid solar power plant scheme in the selected project sites of Telifa. During the public consultations, many people were happy to participate, and the enthusiasm could be seen from the turnout and their composition. During community consultations, women, elders, youth, and village representatives, and priests were present (figure 12)The ESIA team introduced itself and proceeded to disclose the proposed projects, objectives and asked the community members to express their expectations and concerns. Then, opened the floor for discussion, questions, and opinions. Accordingly, the following points were raised by the participants:

5.3.2. Community Consultation At Telifa Proposed Project Site

Table 9: Community Consultation At Telifa Proposed Project Site

Date of meeting: 07/10/2021 **Place of meeting:** In the compound of Saint Merry Church at Telifa site **Number of participants: Men 67 Women 21**		
Name of participant	**Issues raised**	**Responses**
Ato Atinafu Yimer (M)	Expressed that he has information about the project earlier and he is happy as his village is selected for the solar power plant pilot study. He said, "his community does not see any adverse impacts of the solar power plant project, rather it will open up opportunities to increase productivity and other business ideas". The community will be happy if the projects commence as soon as possible	In fact, there was another technical group that selected this site. The site was selected based on many criteria such as land suitability for irrigation, water availability for irrigation, regional government and farmers, productivity, problems related to fuel etc. Now, we are here to study the ESIA related to the construction and operation of this project. So, this discussion is one of the main parts of our study and your view is important for our report and we appreciate it.
Ato Alemu Abera (M)	He welcomed the advent of the proposed solar power plant project to his community. Most of the community members, he said, are exhausted in their effort to secure diesel for their irrigation. Diesel is not only expensive but also not available. If his private farmland is selected for solar panel installation, he is willing to give it and he added that they do not have any objection to this project and they are ready to provide support including Labour.	The issue raised is very important and useful for planning and implementation activities and should be considered. Particularly, the issues raised concerning land for solar panel installation as well as Labour support are remarkable and valued. However, the land will not be taken away for free, rather proper compensation will be paid according to the law of the land.
Ato Melese Abera (M)	He expressed that this project seems to bring with it happiness to all villagers if it materializes soon. He added that our ladies will get relief from smoke, the farmers have been selling out grains and even oxen to purchase diesel. He said we pray this project comes as quickly as possible to the Telifa village.	As the ESIA team expressed earlier, the purpose of this project was to alleviate the problems related to irrigation and power supply to households. For the success of the proposed projects, the community's support is of great importance.
All women participants	Acclaimed their support with hand clapping	All women present in the meeting extended their interest to participate but our efforts to encourage them to speak further did not go beyond the acclaimed acceptance of the upcoming project
All participants (M & F)	All the above respondents raised any potential source of gender-based violence including sexual exploitation of women for short term benefits	The ESIA team responded that gender-based violence is a serious offense and the potential project proponent will have a protocol including training manuals to sensitize and monitor it. If it happens in some way, there will be administrative and disciplinary mechanism to address the offenses

The ESIA team provided equal opportunities to all participants and asked them for any further concerns and eventually requested them to sign on the minutes (see Annex 2).

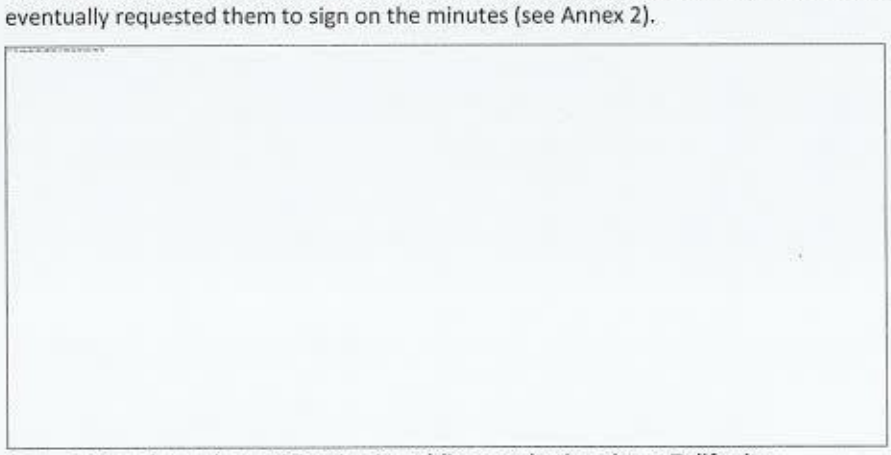

figure 12 Local people participating in public consultation site at Telifa site

5.4. Grievances Redress Mechanism

The mitigation and management plans will be carried out properly. Thus, it is expected that no major grievance issue will arise. However, to ensure that stakeholders have avenues for redressing their grievances related to any aspect that may result from the projects, detailed procedures for the redress of grievances should be established. The objective is to respond to the complaints of stakeholders in a timely and transparent manner without resorting

to complicated formal channels to the extent possible. The procedure covers stakeholder grievances generated during construction and operation activities. Anyone will be eligible to submit a grievance to the project office, if he/she, believes the practice is hurting the community, the environment, or on their quality of life.

5.4.1. Grievance Handling Procedure: Disclosure of the Grievance and redressing Mechanism (GRM)

The Community will be fully informed about the Grievance procedures in their local language. Information about the grievance mechanism will be tailored according to the community to ease communication. Community leaders, social entities, and governmental units will be informed about the GRM. All information about grievance mechanisms will be made available in public areas and with the community leaders.

5.4.2. Mode of Grievance

The proponent will accept comments and complaints associated with the project from any stakeholder. Comments can be made via email, post, fax, telephone, or in person. The proponent will arrange an office to entertain complaints who want to report in person within the project compound. The comments and complaints will be summarized and listed in a complaints/comment logbook, which contains the name/group of the commenter/complainant, the date the comment was received, a brief description of the issues, information on the proposed corrective actions to be implemented (if appropriate), and the date of response sent to the commenter/complainant.

5.4.3. Response to Grievances

All grievances will be registered and acknowledged within 6 working days and responded to within 15 days. The project management will keep a grievance log and report on the progress of grievance management as part of the annual project progress reports, which will be available on the company website. All comments and complaints will then be responded to, either verbally or in writing, by the preferred method of communication specified by the complainant.

6. Potential Environmental and Social Impact Identification and Significance

6.1. General Overview

Identification of all project-induced impacts is an essential output of environmental and social impact assessment (ESIA). ESIA is a process of addressing potential positive and negative impacts of a to design a management action plan before the project construction, development, and implementation phases. It is part of the project planning process and as such helps to prevent and/or mitigate the adverse impacts and enhances a project's beneficial outcomes. In addition, ESIA provides information for decision-makers for better planning and resource management and helps them avoid the negative consequences of the project.

To this end, the potential impacts of the proposed projects were identified in this document and categorized as biological, physical, and socio-economic. The main impacts and their likelihood as well as their levels of impact and severity were identified based on the projects' main activities.

The ESIA team addressed some of the identified impacts based on:
Identification of the main environmental and social resources and receptors from the baseline data collection from project sites
Literature review of impacts of solar generation projects
Results of the stakeholders and community consultations

During the ESIA study, in addition to including some more impacts (based on additional information from the site), a brief description and analysis were made for each impact identified. Accordingly, the proposed project's potential impacts (positive and negative, large, or small, direct or indirect, reversible and irreversible, and significant and insignificant) on the existing biophysical and socio-economic environment and significance are outlined in the next section. Parameters such as Land environment, Water Environment, Air Environment, Noise Environment, and Socio-Economic Environment are of significance in the Environmental Impact Assessment and are being discussed in detail below.

6.2. Beneficial impacts

6.2.1. Economic and environmental benefits

The main purpose of this project is to provide electricity to the community for their irrigation pumps and household use from mini grid solar power plants. The project will have several beneficial impacts both at the national and regional levels. Some of the major positive impacts include the replacement of diesel pumps with electric pumps, which will reduce dependence on diesel and, thus, the reduction of greenhouse gases emission into the atmosphere. In addition, the project will also increase agricultural yield/production, create an employment opportunity for skilled and semi-skilled workers, create an opportunity for knowledge transfer in utilizing best irrigation and agricultural practices, improve social infrastructures, and economic development to the nation at large. The following are some of the positive impacts of the developing project.

6.2.1.1. INCREASING AGRICULTURE PRODUCTION

During the field visit, it was observed that the selected project areas are favorable for modern irrigation activities. However, the farmers are dependent on imported fuel and its cost has been rising over time. Apart from the rise in fuel prices, its availability has been a challenge for farmers. The planned project, generating energy from solar power, is expected to solve many of the farmers' problems. It will provide and/or increase access to water for many farmers and can have significant effects on agricultural productivity and generated income. There will be a

sustainable and diverse food supply throughout the year. Furthermore, the project will increase opportunities to produce market-oriented or high-value horticulture crops for urban centers.

6.2.1.2. EMPLOYMENT OPPORTUNITY

Unemployment is a huge problem in many developing countries including Ethiopia. The development and implementation of this project will undoubtedly be very significant in creating job opportunities for trained, semi-trained local youths during the construction and implementation phases. During the public consultation, one of the community's concerns was about hiring technicians for maintenance not to interrupt the middle of cultivation. The project developer will hire trained experts for repair and maintenance. This proposed project is expected to generate employment opportunities for over 150 people operating at full capacity. This will be a significant impact since unemployment is currently quite high in the city and the country at large. Moreover, unemployed youths in the community will form associations and participate in irrigation activities.

6.2.1.3. ALTERNATIVE SOURCE OF ENERGY

Solar energy that is friendly to the environment, clean, and requires limited maintenance is an alternative renewable energy source, especially for countries like Ethiopia having a high amount of annual solar irradiation rate. Among the various form of renewable energy technologies Solar photovoltaic (PV) technology is perhaps the most used one to generate electricity, especially in rural areas all over the world. Currently in Ethiopia, some people in the rural area use solar energy for household uses. During field visits at project areas, it is observed people using solar for charging mobiles and lights at home.

6.2.1.4. ELECTRICITY SUPPLY FOR THE NEARBY COMMUNITY

The planned solar mini grid solar power plant provides multiple opportunities for the three communities; it will likely save the environment through avoiding deforestation and pollution; reducing women's burden from household chores; enhance community safety and security through provision of stable and affordable energy (light); improved health and education services and enhance the general well-being of the community.

6.2.2. Social benefits

6.2.2.1. GENDER EQUALITY

Irrigation interventions can also affect women's empowerment (or disempowerment) depending on gender roles in agriculture, which vary from case to case. Improved access to the water supply may release women from water-collection chores and might allow women to invest more time in income-generating activities, such as agricultural production. If women are farming their plots and have access to irrigation technologies, then the productivity of female-managed plots may increase, and income from the increase in productivity may also grow.

6.2.2.2. KNOWLEDGE TRANSFER

The project will play a great role in transferring (developing) knowledge and skills in utilizing the best irrigation agricultural practices and solar technology. The youths in the project area will acquire knowledge from construction to operation of the solar mini-grid project. The irrigation users will be organized in an irrigation users' association (cooperative) which can help to disseminate information effectively and efficiently. People from other parts of the country will visit the pilot project and initiate them to implement it in their localities.

6.3. Potential Adverse Impacts and Mitigation Measures

6.3.1. Adverse impacts during the preconstruction phase

Before the commencement of construction, only data collection for the feasibility study and environmental and social impact assessment study were conducted. Baseline data collection and public consultation have been conducted at the site. These activities don't have any significant impact on the environment.

6.3.2. Adverse impacts during construction

6.3.2.1. GENERATION OF SOLID WASTE

The major solid waste expected from this project is damaged solar PV modules during construction. These modules can contain potentially hazardous materials and result in soil and water contamination. Other wastes from the construction site will be mainly residues of the construction material. These include pieces of concrete, heaps of sand and aggregates, bits and pieces of various pipe types, pieces of electrical materials, cans and bags of paint and plastering, packing materials, pieces of timber, scrap, and pieces of metals sheet and iron bar (metals) among others scattered within the project site.

Mitigation measures

- Hazardous waste, including broken PV panels, shall be disposed of in accordance with best industry practice
- Wastes will be kept in a dedicated storage container until the recycled materials are sold and the unwanted materials to be transported to a designated disposal site
- Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean

6.3.2.2. GENERATION OF LIQUID WASTE

During the construction phase, liquid wastes like oil spills from machinery, grease, and petrol in the garage from vehicles are expected to pollute the environment in addition to water wastes from concrete rationing and water sprinkling water wastes from different sanitary uses are expected to increase. Moreover, the accidental release of other hazardous materials from equipment used in the solar panel installation process will likely create liquid waste. If these wastes are not properly managed and mitigated, they can seep into the soil, kill plants, pollute surface and subsurface water, destroy natural habitats and cause biodiversity loss (especially the microbes and small invertebrates) in the area. Furthermore, such continued spill and seepage into the ground will result in the contamination of surface and groundwater sources. These all will further affect human health and well-being in the project command area and beyond.

Mitigation measures

Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills

The wastewater from sanitary and construction works should be collected through the channel in a plastered pond or reservoir and can be recycled for construction, green area, and other purposes after proper filtering and treatment

6.3.2.3. SOIL EROSION

During construction work, a considerable volume of soil will be excavated for leveling site and solar mounting foundation. In the construction area, soils will be impacted due to the clearing of vegetation, mounting of the PV modules, construction of internal roads, etc. Exposure to the ground and removal of vegetation cover will make the soil vulnerable to erosion by wind and running water. However, due to the site's flat topography and the relatively limited earthworks associated with solar PV installations, these impacts are manageable by ensuring good international industry practice in construction works.

Mitigation measures

Topsoil shall be set aside and reserved where possible

Avoid excavation during the rainy season

Heap the excavated soil in the selected area and reuse it to fill undulating areas

Drainage measures shall be provided, prior to construction works, to reduce storm water run-off and flash floods

6.3.2.4. NOISE POLLUTION

During the construction phase, some noises could be generated from construction machinery (like excavators, loaders, bulldozers, mixers, dump trucks, compactors, generators, etc) movements. This may disturb the workers of the project and the nearby villagers to some extent. Noise by nature is a nuisance and may bring about annoyance, sleep disturbance, and interference with communication and cause ear disease if the level is beyond the acceptable limit (WHO prescribes 55dB for residential areas). However, the construction noise will last for a short period and is not expected to cause a significant nuisance to the public, at least not with standard mitigation measures in place.

Mitigation measures

Noisy activities shall be scheduled to daytime hours

Noise disturbance and impact can be reduced by also administration and management decision to work on a shift basis, work rotation and work time reduction for workers to reduce their exposure to noise, moving away the workers from the source of noise by restricting area and shutting or turning off noisy equipment or machineries when not needed

Noise levels at sensitive receptors shall be measured regularly and whenever complaints arise. In instances where workers will be exposed to elevated sound levels, personal protective equipment (PPE) such as ear mufflers/plugs should be used

6.3.2.5. AIR POLLUTION

The main impact to air quality during construction will be from increased dust levels arising from the movement of vehicles and construction machinery, land clearing and leveling, cement mixing (fugitive dust, Pm2.5 microgram per litter), internal road construction, etc. In addition to emissions of particles, there will be minor emissions of CO from construction machinery, vehicles, and diesel power generators. However, due to the relatively long distance between the main PV installation areas and the settlements the impacts are very minor. Principally it is essential to keep control of dust particles during construction since dust particles contribute to air pollution that might limit visibility and affect human and animal health (It adversely and seriously affects human respiratory systems, particularly bronchitis and lung).

Mitigation measure

Workers assigned in the construction machinery operation should wear a dust mask. The supervisor should strictly follow and make sure this procedure is in place before starting their job

Water shall be sprayed on all internal roads to minimize dust dispersion when necessary

6.3.2.6. IMPACT ON PUBLIC HEALTH

The construction of a solar mini-grid power plant involves a high number of workers from other parts of the region. The influx of workers may contribute to a breakdown in social fabrics, norms, and practices, including sexual behavior. Many workers both male & female are expected to involve in the different stages of the construction activities as envisaged in the project feasibility study. Along the process, workers may have a chance to interact with themselves or with any in nearby which might lead to behavioral change which could result in the transmission of contagious diseases such as HIV/AIDS and other STIs. Such incidences may further strain rural health infrastructure and become community health concerns. In addition, ponds and stored water may result in malaria risks and other diseases such as bilharzia (Schistosomiasis).

Mitigation Measures

Prevention will be the key intervention measure and therefore sensitization and awareness measures on HIV/AIDS should be carried out regularly among workers and the host community during the construction phase

Conduct public health campaigns addressing issues of behavioral change, HIV/AIDS, etc.

Putting in place appropriate signage to educate workforce and community about the project's HIV policy

Provision of materials useful for the prevention of HIV/AIDS
A code of conduct shall be in place to manage worker behavior
Conducting malaria awareness raising campaign, using mosquito bite prevention methods such as mosquito nets.

Avoid drinking contaminated water (raising communities' awareness to boil and drink water) to reduce Schistosomiasis infection

6.3.2.7. SPREAD OF COVID-19

The influx of Labour is associated not only with the spread of HIV/AIDS and other sexually transmitted diseases but also with other pandemics such as Covid 19. Coronavirus is a novel contagious disease that is spread through crowding and from the person-to-person transmission of the virus. During construction work, many workers will be involved and work in close contact and this will aggravate the spread of Covid-19 from person to person and also within the surrounding communities.

Mitigation Measures

Workers shall follow strictly Covid-19 prevention mechanisms
Temperature measurement check-up each day at the gate of the compound,
Workers should clean their hands with soap and water, or sanitizers or alcohol many times as much as possible each day.
Keep a safe distance (2 meters) from anyone who is coughing or sneezing.
Workers keep proper physical distance from others (2meter) and always wear a mask and avoid handshake or other physical contacts.
Workers do not touch their eyes, nose, or mouth.
Cover their nose and mouth with their bent elbow or a tissue when they cough or sneeze.
Stay home if workers feel unwell.
If workers have a fever, cough, and difficulty breathing, seek a doctor on time.

6.3.2.8. TRAFFIC ACCIDENT

During the construction phase, there could be traffic accidents associated with the construction of the solar minigrid facility. Specifically, some large trucks, rollers and perhaps excavators will be used. In addition, the roads leading to the project area are not accessible for all vehicles except tracks during the dry season to transport agricultural products. Furthermore, the community awareness regarding the traffic system is also limited. Therefore, unless traffic safety is promoted among workers and the community, traffic accidents could increase during the construction phase

Mitigation Measures

- Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages)
- Collaborating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)
- Mandatory speed limits not exceeding 40km per hour

6.3.2.9. IMPACTS ON FLORA

The construction work is only limited for solar panel construction site, since there is no plan to construct irrigation components as seen from design (Figure 2) The selected solar mini grid project site consists of areas that are sparsely vegetated or have no vegetative covers, and hence no trees will need to be removed as part of construction. However, limited amount of vegetation will be cleared at solar panel erection site during construction.

Mitigation Measures:

Replantation in other part of the area to compensate amount of vegetation cleared

6.3.2.10. LANDSCAPE CHANGE AND VISUAL IMPACTS

During the construction phase, the existing relatively flat topography may change due to excavation and leveling, in addition, the excavated overburden materials and construction materials left over inside the site and surrounding area may create visual impacts.

Mitigation Measures:

Use the excavated soil for backfill during site restoration phase

Properly store and finally clear construction leftover materials

6.3.2.11. GENDER BASED VIOLENCE (GBV)

Gender-based violence involves power imbalances where, most often, men are the perpetrators and women the victims. While women are usually the immediate victims of gender violence, the consequences of gender violence extend beyond the victim to society. Experience from other projects indicates that among the most serious and invisible risks is the increase in gender-based violence (GBV) in the populations in which a project is carried out. For this specific project during the construction phase, there will be a very small, temporary labour influx which may result in gender-based violence (GBV) and sexual exploitation risks for women and girls, although unlikely this issue should have modest monitoring.

Mitigation measures

The main measures to minimize these cases in the context of development projects include preventive measures such as codes of conduct, worker training, and specific complaint mechanisms to address sexual violence. The proponent should work closely with local women's support groups, organizations, and institutions that can provide the timely and immediate support that girls and women require.

6.3.2.12. CHILD LABOUR ABUSE

In most parts of the country in Ethiopia including this specific project area, the culture encourages children to work to develop skills. Children are considered assets to generate income in a time of poverty. Children should, therefore, be given work at home early in life and be obliged to assist parents in the farming area. During the construction phase, children may become involved in construction activities by running errands or doing simple tasks. These activities could keep the children away from school in addition to the risk of being exposed to accidental and other injuries.

Mitigation measures

Continuous monitoring of contractor's compliance to national labour laws and AfDB's OS5

6.3.3. Adverse impact during Operational or implementation phase

6.3.3.1. IMPACTS ON BIO- PHYSICAL ENVIRONMENT

6.3.3.1.1. Soil Contamination and Soil Fertility Decline

Solar mini-grid power plant facilities do not involve significant risks of pollution spills or the release of other hazardous materials during the operation phase. However, as mentioned earlier, solar PV modules and batteries contain potentially hazardous materials and need to be disposed of safely at the end of their use and when they are damaged during the operation phase.

Mitigation measures

- PV panels and batteries at the end of their useful life, and other potentially hazardous waste generated during the operation phase, shall be disposed of in accordance with best industry practices

6.3.3.1.2. Soil erosion

The proposed solar mini-grid plants at the site have flat laying topography, and the expected soil erosion during the operation phase is very minimal. However, there will be a need to provide drainage around the solar mini-grid plant to prevent localized flooding and erosion. This will be considered in the detailed engineering phase as a measure to safeguard the solar PV installations as well as for environmental protection.

Mitigation Measures

Plant trees in areas exposed to flooding
Provide permanent drainage at the project site to prevent flooding and soil erosion
Avoid discharging excess water over in the irrigable site

6.3.3.1.3. Water Contamination

The project areas are rich in surface and groundwater; therefore, any improper discharge of pollutants may contaminate the water bodies significantly. The major river (Gumera) and other tributaries drain to Lake Tana, yet the contamination may go beyond the farmland and could impact the lake unless proper waste management is practiced. The impact of water pollution from solar PV plants during the operation phase is very minimal. The expected potential source of water pollution is from the permanent workers (e.g., Guard, technician) facilities, therefore, sources from these facilities may generate sanitary effluents

Mitigation Measures

- Ensure proper facilities and disposal processes exist for waste and water at the minigrid site and toilet/guardhouse facilities.

6.3.3.2. IMPACTS ON BIODIVERSITY (FLORA AND FAUNA)

The planned solar PV installation area is sparsely covered with bushes and grasses. Clearing of vegetation will be conducted at the start of construction, once the solar PV installation is completed impact on flora will be minor.

6.3.3.2.1. Risk of bird fatalities:

During the site visits, a variety of bird species were observed, this is maybe due to the proximity of sites to Lake Tana and availability of food on the lake and surroundings. Recent studies have demonstrated that utility-scale solar developments represent a source of fatality for wildlife such as birds (e.g., Kagan et al. 2014). However, the risk is highly dependent on the type of technology with several impacts confined only to concentrating solar power (CSP) and power tower technologies (Walston et al. 2016). The impacts may also not be greater than for any other facility with above-ground structures including window strikes on buildings and bird collisions and electrocution with distribution lines.

Mitigation Measures

- Select PV panels with minimal light reflection to protect birds from collision and remove weeds manually and avoid using pesticides.
- Rehabilitation of trees through planting
- Stakeholders should work hand in hand with demographic pressure on diminishing natural resources rather than starving to meet their own individual interests at the expense of the park and its objectives

6.3.3.3. IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

6.3.3.3.1. Loss of farmland

Though the implementation of the irrigation project has numerous benefits for most of the local communities, the construction of solar PV will occupy a sizable amount of land not more than 0.5 hectares per site. Hence, land take will result in permanent loss of agricultural and grazing lands. However, the area needed for solar is so small and there is a chance to construct on communal land. Therefore, it does not result in economic displacement for farmers.

A public consultation was conducted, and the communities agreed to hand over land for solar panel installation if compensation payment is made as per the provision of the law (proclamation no. 1161/2019).

Mitigation Measures

Landowners shall be compensated as per the new proclamation No. 1161/2019 before the construction activities start

Provide job opportunity priority for those projects affected people (PAP) during construction and implementation phases

6.3.3.3.2. Noise pollution

Both the irrigation activities and solar PV facilities emit insignificant sound pollution. Therefore, noise impact will likely be insignificant and may not need mitigation measures.

6.3.3.3.3. Air pollution

Air pollution is one of the serious environmental and social problems which creates several adverse effects on human health due to their nature and residence time in the atmosphere. In addition to its negative effect on human health, it exerts a strong effect on local and global climate change. Air pollution is often intensified in connection with development activities such as agriculture (irrigation) and industry. Hence, the source of air pollution and its mitigation measures should be understood and analyzed in advance before the commencement of any project development and implementation. Upon commissioning, the solar PV plant will supply renewable energy using a technology that does not involve the release of greenhouse gases (GHG) during operation. Compared to diesel generators or other thermal power plants, solar PV facilities can thus contribute to reducing air pollution.

Mitigation Measures

- Measure levels throughout lifetime of project and address as needed

6.3.3.3.4. Generation of liquid waste

During the operation phase, the generation of liquid waste from the Solar PV plant is very limited. The major source of liquid waste emanates from sanitary wastewater from restrooms.

Mitigation Measures

Construct a septic tank inside the premise and collect sanitary waste and finally dispose of it at permitted area.

6.3.3.3.5. Occupational health and safety

The health and safety risks during the operation phase will be limited to solar PV site workers. Technicians will be exposed to electric shock, burns, and body damage as they undertake routine operations and maintenance tasks.

Mitigation measures

Use of appropriate PPE during installation and maintenance
The solar PV plant shall be equipped with a fire-fighting system

6.3.3.3.6. Contagious diseases (STDs, HIV, TB) and Covid-19

The operation phase of the solar PV project involves a limited number of workers; however. The influx of Labour is often associated with the spread of communicable diseases such as HIV/AIDS and other sexually transmitted diseases. Coronavirus disease is also a new and potentially dangerous contagious disease that is spread through crowding and from person-to-person contacts. In addition, it is expected that a disproportionate percentage of the Labour force will be constituted of the young population in their sexually active age hence exposure to STDs (e.g., HIV) would be expected.

Mitigation measures:

Health promotion: sensitization of both community and workforce
Provision of materials necessary for prevention and detection of COVID 19
Provision of materials useful for the prevention of HIV/AIDS
Having in place appropriate signpost to educate the workforce and community about the Project's HIV policy and project COVID management and prevention policies

6.3.3.3.7. Fire hazard

During the operation phase of the project, there could be different activities that may lead to a fire outbreak. Poor handlings of Solar PV components like AC and DC converters, and transformer & electricity systems, faulty electrical equipment, carelessness, etc. are some of the possible causes of a fire outbreak. The effects may result in total damage from fire hazards which could permanently affect the project and may result in loss of property and life.

Mitigation Measures

The solar PV plant shall be equipped with a fire-fighting system
The technician should regularly inspect Solar PV components

6.3.3.3.8. Impacts on tourism and cultural heritage

As described earlier in this document, Fogera is rich in different cultures and tourist attraction areas. However, the information obtained from public consultation, the woredas culture and tourism office, and field visits conform to the absence of known cultural heritage resources at the project site. However, as always, there is a risk that cultural heritage objects are unexpectedly uncovered during construction activities. The project area is situated about 7km far from the main road to Bahir Dar and Gondar, both cities are known tourist destinations in Ethiopia. The establishment of this project adds a positive impact on tourism activity. Government representatives from different parts of the country, researchers, students, etc., might be attracted to visit the solar PV facility for educational purposes and to implement it in other parts of the country.

Mitigation Measures

- Prepare chance finds procedure based on World Bank

6.3.3.3.9. Child Labour Abuse

In most parts of Ethiopia, including this specific project area, the culture encourages children to work to develop skills. Children are considered assets to generate income in times of poverty. Children should, therefore, be given work at home early in life and be obliged to assist parents in farming areas. During the operation phase, the minigrid developer will not have any role to hire children in to, so this is a highly unlikely risk for the operation of a solar energy power plant.

Mitigation measures

- Provide training for families not to participate children underage
- Strictly monitor compliance to national labour law and AfDB's OS 5

6.3.4. Impact during decommission phase

Information from different literature reviews reveals that power PV plant is expected to have an economic life span of 25 to 30 years and are more likely above with proper maintenance and interim replacement of major equipment (National Renewable Energy Labouratory 2012). Once the power generation ceased, it is mandatory to decommission the solar modules and all associated equipment and facilities to return the affected area to the natural environment.

6.3.4.1. AIR POLLUTION

Similarly, in the construction phase, the dismantling of the solar PV equipment and unwanted constructed structures will create dust emissions. The dust results in respiratory problems and other health impacts on decommissioning workers.

6.3.4.2. GENERATION OF SOLID WASTE

During the decommissioning phase, solid waste will be generated after the use-life of solar modules, cables, substructures, demolished civil structures, etc. Solar modules can contain potentially hazardous materials, so

consideration should be given at the start of a solar PV project as to how units will be disposed of at the end of their use-life.

Mitigation Measures

Workers should wear dust masks
Spray water on demolishing areas
hazardous wastes should be dumped in specified protected site

6.3.4.3. LOSS OF EMPLOYMENT

The solar PV project will create jobs for a limited number of workers during the implementation phase. When the project phases out, permanent workers will be jobless and will likely be negatively affected.

Mitigation Measures

Transfer permanent workers to other active projects
Pay compensation (severance) for permanent workers

6.3.4.4. NOISE POLLUTION

The decommissioning activities of dismantling the solar power plant and removing the ancillary facilities are associated with potentially increased noise levels. The receptors of the increased noise level will be only the workers of decommissioning activities.

Mitigation Measures

As the only receptors will be the workers at the site and within the proposed facilities within the vicinity of the solar power plant, these increased noise levels are considered occupational noises that require occupational health and safety measures, like wearing air plugs

6.3.4.5. LABOUR INFLUX AND GBV

The activities associated with decommissioning will involve dismantling of the solar power plant, irrigation pipes and removal of its facilities. These activities involve a limited number of workers. Hence it may have a temporary effect. We don't anticipate any insignificant impact on gender related violence and spreading of communicable disease like HIV, Covid 19, etc. Similarly, the participation of underaged workers will be unlikely since the number of workers required for the decommissioning phase is very limited.

6.4. Significance of impacts

Identification of impacts significance and analysis is a core element in an ESIA process. It involves impact identification, prediction, and evaluation. The most possible potential impacts associated with this project were identified using professional exposure to similar projects, from collected baseline data, community consultation, and professional judgments.

Based on these factors, the identified impacts of the project on the bio-physical and socio-economic environment of the area were evaluated and predicted. The identified impacts were evaluated to determine their significance by using typical parameters; type, duration, nature, magnitude, and significance through the project development periods as indicated in Table 10.

The parameters used in evaluating the magnitude and likelihood of the impacts are briefly addressed in the table. Spatial and temporal extent, the natural resources carrying capacity and possible potential environmental sustainability because of the impacts of the identified parameters were done. Based on these factors, the most possible impacts of the project on the bio-physical and the socio-economic conditions of the project area were evaluated.

Table 10: Impact Significance Evaluation Criteria

S. No	Criteria	Impact rating	Description
1	Extent of the impact	Local	Site specific or confined to project premise
		Regional	Extending beyond the boundaries of the project site and its buffer zone, affecting neighbors, town, local authority, district and even province
		National	Affecting areas beyond the province.
2	Magnitude	Very low	Where the impact affects the environment in such a way that natural, cultural and social functions, and processes are not affected.
		Low	Where the impact affects the environment in such a way that natural, cultural, and social functions and processes continue, albeit in a slightly modified way
		Medium	Where the affected environment is altered, but natural, cultural, and social functions and processes continue, albeit in a modified way.
		High	Where natural, cultural, and social functions or processes are altered to the extent that it will temporarily or permanently cease.
3	Nature	Permanent	When the effect is long-lasting
		Temporary	When the effect is for a short period of time

Table 11: Potential Environmental And Social Impacts Evaluation

S. No	Main Identified Potential Impacts	Type		Reversibility		Impact Extent		Nature		Magnitude	Significance
		Beneficial	Adverse	Reversible	Irreversible	Local	Trans-Region	Temporary	Permanent		
I.	**Potential positive impacts**										
1.	Employment opportunities	x		x		X		X	x	Medium	Medium
2.	Agriculture productivity	x		x		X	X		x	Very High	Very High
3.	Knowledge transfer	x		x		X	X		x	Medium	Medium
4.	Gender Equity	x		x		X		X	x	Medium	Medium
II	**Potential Adverse Impacts**										
Construction Phase Impacts											
1.	Generation of Waste		x	x		X		x		Medium	Medium
2.	Generation of noise		x	x		X		x		low	low
3.	Dust emission		x	x		X		x		low	low
4.	Impact on public health		x	x		X		x		Medium	Medium
5.	Workplace Accidents		x	x		X		x		Medium	Medium
6.	Covid 19		x	x		X	X	x		High	High
7.	Soil erosion		x	x		X		x		Medium	Medium
8.	Traffic Accident		x	x		x		x		Medium	Medium
9.	Landscape change and visual impacts		x	x		x		x		Medium	Medium
10.	GBV		x		x	x			x	High	High
11	Child Labour abuse		x		x	x			x	High	High
Operation Phase Impacts											

1.	Air emission/pollution		x	x		X			x	low	low
2.	Noise pollution		x	x		X			x	Very low	Very low
3.	Over abstraction		x	x		X			x	Medium	medium
4.	Siltation		x	x		X			x	Medium	medium
5.	Water pollution		x	x		X			x	Medium	Medium
6.	Soil contamination		x	x		X			x	Medium	medium
7.	Impact on fauna		x	x		X			x	low	low
8.	Impact on flora		x	x		X			x	Medium	medium
9.	Covid 19		x		x	X	X		x	High	High
10.	Sexually transmitted disease		x		x	X	X		x	Medium	Medium
11.	Impact on public health		x		x	X			x	Medium	medium
12.	Fire Hazards		x		x	X			x	High	High
13.	Traffic accident		x		x	X			x	low	low
14.	Occupational health and safety		x		x	X			x	Medium	Medium
15.	Impacts on culture, tourism		x		x	X			x	low	low
16.	Loss of land		x		x	X			x	High	High
17.	Child Labour abuse		x		x	x			x	High	High
Decommission phase impact											
1.	Pollution		x		x	X			x	low	low
2.	Loss of employment		x		x	X			x	low	low

7. Project Alternatives

During Environmental Impact Assessment, it is crucial that assess feasible alternatives for the project to bring sustainable development in the area. Therefore, before deciding on the proposed solar panel irrigation design and implementation of the project in general, several project options were examined to select the feasible alternatives considering biophysical, social, economic, and technical factors. The alternatives considered were:

1. No project alternative: The "No action or do-nothing option" hinders the implementation of an irrigation project in the area using solar as an energy source. This option limits or excludes the benefits of the local community that will be gained from the modern irrigation system. If the solar project cannot be implemented, the price of fuel for their pump will be more costly to the community. In addition, the major benefits like increasing agricultural products and income of the people from the project will be lost. Moreover, it contradicts the interest of the people towards the project as well as the socio-economic development need of the nation by using the available water resources (see water management policy). As a result, this option was not found to be feasible.

2. Other source of power (Hydro, Fuel, Wind): The sites are far from the main electric line, and it will be more costly to get power from the main grid. The sites are not favorable for generating power from wind. Currently, some farmers use fuel for their pumps but the cost of fuel increases from time to time (40 to 50 birr per litter), and is not economical to proceed with further irrigation activities. Environmentally, it is not advisable to use fuel for the pump. The ESIA team measured carbon monoxide (CO) in the field while the pump working with fuel and read 56 ppm whereas in the absence of pump/ideal time the measurement is 0 ppm.

3. Project implementation option: The planned project in the selected areas has numerous advantages for the local community. The community can get sustainable energy sources for their irrigation activities, and it enables them to increase agricultural products. Save the community from extra fuel costs and the environment

from pollution. The community can also get electricity for their home, school, health post, and their flour mill, getting electricity for these infrastructures will improve the services which provide to the community.
Generally, all the above-mentioned alternatives were analyzed based on technical feasibility, economic viability, and environmental acceptability. Then, the "No Action" alternative has not been accepted while the project implementation option using solar energy is selected because of the numerous project advantages of the project to the local community, and the low negative impacts of the project on the social and biophysical environment.

8. Environmental and Social Management Plan

8.1. General Overview

One of the objectives of undertaking an Environmental and Social Impact Assessment (ESIA) is to develop an Environmental and Social Management Plan (ESMP), which outlines the costs, timeframes, and responsibilities for the implementation of the proposed mitigation and enhancement measures. It identified all measures considered for the Mini grid project activities in the handling of impacts that were significantly generated by environmental impacts. These include:

- A mitigation plan with mechanisms and actions to minimize negative environmental impacts during construction, operation, and decommissioning
- A compensation plan with measures for designing activities to restore the environment
- A risk- and accident prevention plan linked to the construction, operation, and decommissioning of the mini grid solar projects
- A public-participation plan that involves stakeholders
- A training plan to adequately meet human-resource needs

The sole responsibility for the implementation and outcome of the ESMP rests with the project proponent. In this case, the developer will be responsible for the implementation of ESMP. The proponent has to incorporate an environmental management system in its daily operations and its ESMP is implemented, maintained, and updated in a manner that is consistent with nationally and internationally recognized standards. The environmental management issues an outline in this ESMP, that will be used to manage all environmental and social aspects of the operations activities. The proponent should ensure that it puts in place the essential institutional setup (Environment, Health, and Safety unit) and hire competent, experienced, and qualified person(s) to implement the ESMP.

8.2. Institutional framework

This section assesses institutional issues for implementing the ESMP and its monitoring plan, accordingly recommends a reporting and monitoring framework before discussing the mitigation measures for each identified impact in detail. The implementation of mini-grids in this project will directly involve the project proponent, the duty and responsibility of managing the environmental and social impacts should therefore be the sole responsibility of the project proponent.

For this project, the Amhara regional bureau of agriculture and natural resources, water and energy, Lake Tana and Other Waters Management Agency, etc., will be responsible for enforcing compliance with national standards in the different areas of specialization. At the national level, the Environmental Protection Authority (former EFCC) is responsible for evaluating and approving ESIA study reports as well as for providing environmental approval licenses which must be obtained before the commencement of project implementation. In addition, the environmental protection Agency of the Amhara regional state is expected to be involved in the monitoring of the environmental performance of the solar power PV project in the Amhara region.

The contractor should maintain adequate control over the project to minimize the extent of impacts during construction, ensure appropriate restoration of areas affected by construction activities and prevent long-term environmental degradation.

8.3. Air Quality and noise management plan

The intended project will have some pollution impacts on air and noise to workers during the construction, operation, and decommissioning phases therefore, the project proponent has to do its bests to comply with the performance standard that deals with pollution prevention and abatement.

During the design, construction, and operation of the mini-grids, the project proponent has to consider ambient conditions and apply pollution prevention and control technologies and practices (techniques) that are best suited to minimize or reduce adverse impacts on human health and the environment. Noise levels at the nearest sensitive receptors shall not exceed Ethiopian or international standards for daytime and nighttime noise. Regular measurements of noise level (Leq, dBA), using a standard sound level meter, shall be carried out to demonstrate compliance.

8.4. Occupational Health and safety plans

The project proponent provides safety wear, safety equipment, and occupational safety training before replacing and maintaining solar modules. To attain workplace safety, some construction machines and solar PV components shall have protections, warning stickers, automatic stopping, or safety switches. Fire extinguishers should be placed in proper places which are easy to access during an emergency. Depending on the site context of workplaces and the types of machinery workers shall be provided with safety wear such as goggles, hand gloves, work clothes, dust masks, safety shoes, working manuals, etc.

For example:

Providing information materials, instructions, and regular pieces of training for employees regarding workplace injuries and hazards.

Regular reporting and consultation with employee-elected health and safety representatives and/ or other employees about occupational health, safety, and welfare situations.

Providing adequate personal protective clothing and equipment to ensure safety

Ensuring all work procedures are undertaken without exposing workers to hazards.

8.5. Waste management plan

The selected project site is in a rural space with no proper waste disposal site. Therefore, it is the proponent's responsibility to manage hazardous (e.g., accidental leakage of energy storage batteries) and non-hazardous wastes following the guidance included in the General Ethiopian Guidelines.

Management and disposal of hazardous and non-hazardous wastes should be undertaken following guidance included in the "General Ethiopian Guidelines".

8.6. Community Engagement Plan (CEP)

The proposed solar mini-grid plant has planned to supply electricity to the nearby community but, the main objective of this project is, to provide a reliable supply of energy for irrigation so that smallholder farmers increase their farm productivity and mitigate climate change impacts. Farmers often use diesel pumps to irrigate their farms. Nonetheless, they face multifaceted problems such as rising diesel prices due to inflation, shortage of fuels in the market, and frequent maintenance-related costs of the pumps. During the public consultations, the ESIA team witnessed that the community members of the four sites were eager to see the implementation of this project. Hence, such a positive outlook and good relations with the community, should be promoted by implementing an action plan that aims to provide a timely response to any inquiries, concerns, or complaints about construction or operation activities. The project proponent should consult and disclose any problems during operations, particularly regarding the disclosure of information related to effluents, public health, safety issues, and reporting results of environmental monitoring. The project should continue to remain in contact with irrigation user communities, local and regional agriculture offices, energy experts at various levels, and other stakeholders during the period of operation. Ongoing stakeholder consultation will allow the project to receive and respond to community concerns on an ongoing basis.

- The Community Engagement Plan (CEP) should be designed on the following principles:
- A Community Liaison Officer for each site needs to be appointed.
- The Community Liaison Officer will initiate the CEP through consultation with key stakeholders identified during community consultation
- A formal CEP should be produced and documented in consultation with all key stakeholders.
- Through the Community Liaison Officer, the solar PV project proponent will implement a community grievance mechanism allowing community members to raise their concerns about any environmental or social concerns that they may have concerned the project.
- The project proponent will likely take responsibility for the implementation of the ongoing CEP.

8.7. Community Health and Safety Plan

The proponent will be responsible for safeguarding the health and safety of the public. During the construction phase, an influx of workers will be expected from another part of the country. The spread of Covid 19, HIV/AIDS, and other Sexually Transmitted Diseases (STDs) will be expected. In addition, due to the increased movement of construction machinery and dump tracks, traffic accidents will be one of the problems for the residents.

To mitigate above mentioned potential impacts the following activities should be carried out
Support the local government in improving access to clean water
Create awareness between workers and the community to prevent communicable diseases (HIV, Covid19, and other STDs)
Enforce the drivers to limit speed (not more than 40km/hr.) in the project area and surroundings
Aware the communities about traffic accidents through campaigns
Put the traffic and other safety signage in the project sites during construction and operation

8.8. Construction phase Environmental Management Plan

Table 12: Summary Of Construction Phase Management Plan

	Identified Impacts	Mitigation measures	Responsible Body	Estimated cost
Biophysical Environment	Generation of solid Waste	Hazardous waste shall be disposed of in accordance with best industry practices Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean	Minigrid Contractor	Estimated cost for disposal of solid waste 50,000 birr
	Generation of liquid Waste	Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills The wastewater from sanitary and construction works should be collected through a channel in a plastered pond or reservoir and can be recycled for construction, green area, and other purposes after proper filtering and treatment. Very minimal amount of wastewater for Minigrid, very limited amount of fuel or hazardous material	Minigrid Contractor	For construction of plastered pond and other storage structure is 100,000 birr
	Soil erosion	Avoid excavation during the rainy season Heap the excavated soil in the selected area and reuse it to fill	Minigrid Contractor	Labour cost to pile up soil is 60,000 birr

	Identified Impacts	Mitigation measures	Responsible Body	Estimated cost
		undulating areas		
	Noise pollution	Noisy activities shall be scheduled to daytime hours Noise disturbance and impact can be reduced by also administration and management deciding to work on a shift basis, work rotation and work time reduction for workers to reduce workers exposure to noise, etc. Personal protective equipment such as ear mufflers/plugs should be used	Minigrid Contractor	For purchasing PPE is 30,000 birr
	Air pollution	Workers assigned in the construction should wear a dust mask. The supervisor should strictly follow and make sure this procedure is in place before starting their job, and Water shall be sprayed on all internal roads to minimize dust dispersion when necessary	Minigrid Contractor	PPE included above, and water spray is 30,000 birr
Human Environment	Public health including Covid 19	Conduct public health awareness campaigns addressing issues of behavioural change, HIV/AIDS, etc. Prepare training manual and conduct regular training about STDs Provision of materials useful for the prevention of HIV/AIDS Workers shall follow strictly Covid19 prevention mechanisms such as temperature measurement at the gate of the compound, washing of hands, wearing of masks, avoid handshake, and keep social distance as much as possible.	Community /woreda labour and women affairs office Internal training by Minigrid Developer	Awareness-raising and training 25,000 birr For internal half day training 30,000 birr
	Gender-based violence/child labour	Provision of training for workers and families, Community sensitization, regular monitoring for EHS compliance	Community/ Woreda labour and women's affairs office	100,000 birr for training, and regular monitoring
	Traffic accidents	Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages) Mandatory speed limits not exceeding 30km per hour Collaborating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)	Minigrid Contractor in collaboration with Woreda traffic police	Training cost for awareness creation for community and workers 20,000 birr
	Impacts on cultural, historical and archaeological site	If, in case, during excavation works a religious or historical site is found or suspected to be found, Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of the construction procedure manual	Minigrid Contractor supervised by Amhara regional state culture and tourism office	Supervision cost 20,000 birr
Total Cost				465,000 birr

8.9. Operational phase Environmental and Social Management Plan

Table 13: Summary Of Operational Phase Management Plan

	Identified Impacts	Mitigation measures	Responsible body	Estimated cost
	Liquid waste	Construct a toilet inside the premise and collect sanitary waste and finally dispose it off at permitted area	Minigrid Developer	Toilet is expected to be constructed during construction phase
Biophysical Environment	Loss of farm and grazing land	Landowners shall be compensated as per the new proclamation No. 1161/2019 before the construction activities started Provide job opportunity priority for those projects affected people (PAP) during construction and implementation phases	Minigrid Developer, Woreda Agriculture offices, Woreda administration	The cost will be estimated later by Woreda experts
Human Environment	Occupational health and safety	Use of appropriate PPE during installation and maintenance The solar PV plant shall be equipped with fire-fighting tools Ensuring all electrical equipment and machinery are properly grounded Maintenance should be conducted by trained professionals only	Minigrid Developer	Estimated cost to purchase lifetime PPE is 60,000 birr

	Identified Impacts	Mitigation measures	Responsible body	Estimated cost
	Fire hazards	The solar PV plant should be equipped with proper fire extinguishers The technician should regularly inspect Solar PV components	Minigrid Developer	fire protection systems 80,000 birr
	Impacts on cultural, historical and archaeological site	If, in case, during operation if religious or historical site is found or suspected to be found, Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of construction procedure manual	Contractor, supervised by Amhara regional state culture and tourism office	No cost is implied
			Total cost	140,000 birr

8.10. Decommission phase Environmental Management Plan

Table 14: Summary Of Decommission Phase Management Plan

	Identified Impacts	Mitigation measures	Responsible Body	Estimated cost
Biophysical Environment	Generation of solid Waste	Hazardous waste, including broken PV panels, used batteries, shall be disposed of in accordance with best industrial practices	Minigrid Contractor	Waste disposal cost 150,000 Birr
	Air pollution	Workers assigned to the demolition should wear dust masks. Spray water on demolishing areas	Minigrid Contractor	PPE purchase and water spray cost 40,000 Birr
Human Environment	Loss of employment	Transfer permanent workers to other active projects Pay compensation (severance) for permanent workers	Minigrid Contractor /Regional government	Compensation payment for workers should be paid by the project proponent
	child labour	Provision of training for workers and families, Community sensitization, regular monitoring for EHS compliance	Community/ Woreda labour and women's affairs office	20,000 Birr for training, and regular monitoring
			Total Cost Decommissioning (Birr)	210,000 birr
Total ESMP + ESMMP cost (Construction, Operations, Decommission, Monitoring) with Minigrid + local/government parties combined				965,000 birr

9. Environmental and social monitoring plans

Monitoring usually takes two forms, i) compliance monitoring and ii) effect monitoring. The former is whether impact mitigation and enhancement measures are implemented in time and to the agreed national and international standards. Whereas the latter refers to monitoring of project-induced impacts on the social and biophysical receptors. Thus, the compliance aspect is monitored by government authorities at the federal level (EPA) and the Amhara regional bureau of environmental protection authority in Figure 13.

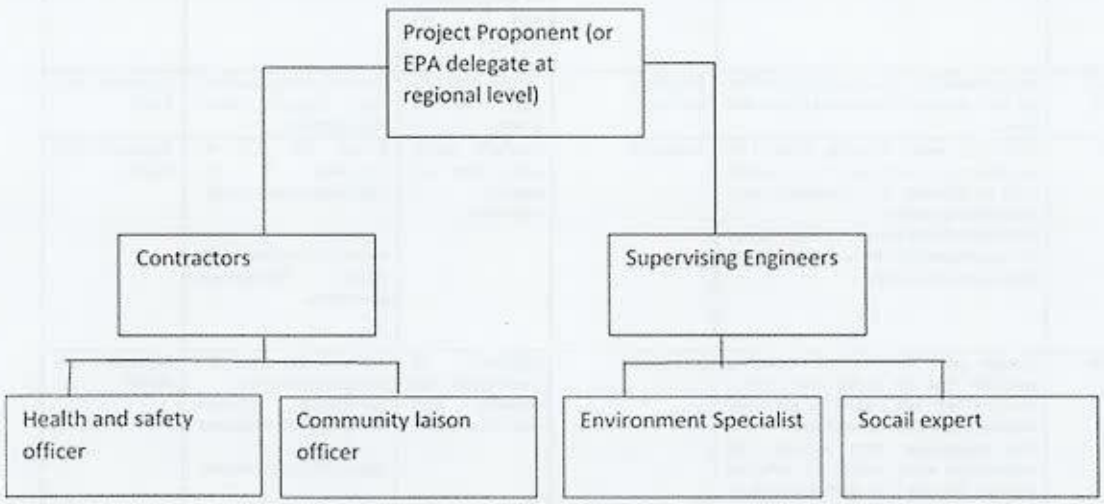

Figure 13 Organizational Structure for Compliance Monitoring

The main objective of the environmental monitoring plan is to ensure that the predicted outcome of the company is achieved. The overall objective of this EMP is to integrate environmental and social considerations into account to ensure the successful economic and social development of the project. The regular monitoring program will determine whenever changes or operations are required to reduce the negative impacts and to enhance the beneficial ones. Therefore, conducting monitoring will be of paramount importance.

Effect (target) Monitoring: Periodical ambient air quality measurement should be conducted at solar PV installed areas and around irrigated farmlands and the quality of the water effluent should be monitored regularly for all critical parameters such as Biochemical Oxygen Demand (BOD), pH, Total Dissolved Solids (TDS), Total Suspended Solids), alkalinity, hardness, and turbidity. In addition, soil samples should be collected from irrigated farms and monitor changes in soil fertility. Fogera Woreda Environmental protection office should periodically conduct their own independent monitoring for compliance with national standards. The project proponent should submit an annual compliance report indicating all the monitoring results to Fogera woreda Environmental protection office as well.

Table 15: environmental monitoring plan

Parameters to be monitored	Mitigation measures	Responsible	Monitoring schedule	Monitoring indicators	Monitoring cost (Birr)
Contract management	Make sure the contractor has prepared ESMP for approval by the client	Proponent	Pre-construction and construction phases	Copy of the approved ESMP and implementation of it	Cost internal to developer to get approvals
Social support to vulnerable people	Job opportunities for project-affected people (loss land), Landowners should be compensated as per proclamation No. 1161/2019	Proponent	Throughout operation phase Note: selected land is expected to be community land, not individual	Interview vulnerable people, field visit, Check the amount of money paid out from finance	Supervision cost 5,000 birr
Employment opportunity	Hire workers from local people depending on their education preparedness and skill level	Proponent & Woreda	At the beginning and annually months	Number of local workers from company human resource office	Supervision cost 5,000
Solid waste	Hazardous waste, including broken PV panels or panels at the end of their use-life, shall be disposed of in accordance with best industry practice Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean	Proponent	Quarterly during construction and annually in operation	Annual site visit to determine if any hazardous waste is on site Disposal of hazardous waste in compliance with waste management procedures	Supervision cost 10,000
Liquid waste	Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills The wastewater from sanitary and construction works should be collected through channels in a plastered pond or reservoir and should be recycled for reuse during construction	proponent	Beginning of construction and annually each year of Operation	Annual check that the necessary are in place Constructed plastered pond/ reservoir if required Amount of water recycled	Supervision cost 10,000
Noise pollution	Noisy activities shall be scheduled to daytime hours personal protective equipment such as ear mufflers/plugs will be used	Proponent in collaboration with Woreda health experts	Weekly during the construction phase	Noise level should not exceed the world bank standard (55dBA and 45 dBA during the day and night times, respectively)	Cost for regular checking of noise level 5,000
Air pollution	Workers assigned in the construction should wear dust masks. The supervisor should strictly follow and make sure this procedure is in place before starting their job; and Water should be sprayed on all internal roads to minimize dust dispersion when necessary	proponent collaboration with Woreda health experts	Periodically during the construction and operation phase	Check air quality measurement, Air emission shouldn't exceed WHO standards Supervise workers proper use of PPE's Complaints from the local governor, community	Expert cost for regular check emission level 5,000
Loss of farm and grazing lands	Landowners should be compensated as per the new proclamation No. 1161/2019 before the construction activities started Provide priority to a job opportunity for those projects affected people (PAP) during construction and implementation phases	Proponent	Before commencement of construction work	Check the amount of money paid for PAP Contractor's personnel office documentation	No cost
Traffic accident	Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages) Mandatory speed limits not exceeding 40km per hour Collabourating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)	Proponent collaboration with Woreda traffic police	Every three months during construction, annually during operations	Number of accidents on the site Speed limits put at appropriate places Erected traffic sign	Supervision cost 5,000
Sexually transmitted diseases like HIV	Health promotion: sensitization of both community and workforce Provision of materials useful for the prevention of HIV/AIDS Having in place an appropriate signpost to educate the workforce and community about the Project's HIV policy	Woreda health office	Every month during the construction and operation phase	Number of distributed condoms Check the number of trainings conducted	Training cost 100,000

Parameters to be monitored	Mitigation measures	Responsible	Monitoring schedule	Monitoring indicators	Monitoring cost (Birr)
Covid 19	Train workers to follow strictly Covid-19 prevention mechanisms Temperature measurement check-up each day at the gate of the compound Provision of materials necessary for prevention and detection of COVID 19	Proponent in collaboration with Woreda health experts	Regularly during construction and operation	Number of Covid-19 infected	Expense already included in construction and operations No cost to report # of cases
Occupational Health and safety	Use of appropriate PPE during installation and maintenance The solar PV plant shall be equipped with a fire-fighting system Ensuring all electrical equipment and machinery are properly grounded;	Proponent	Regularly during construction and operation	Total recorded incidence rates	for provision of first aid a lump sum of 5,000
Fire hazards	The solar PV plant should be equipped with a fire-fighting system The technician should regularly inspect Solar PV components	Proponent	Every three months during the construction and operation phase	Number of incidents and reported cases	Part of project and operation cost
Impacts on historical, cultural heritage	Excavation work should be done carefully as per World Bank Guidelines - OP 4.11 and prepared chance find procedures	Contractor	During construction work	Number of discovered heritage site or artifacts	Part of supervision cost
Total monitoring cost					150,000

10. Conclusion and Recommendations

10.1. Conclusions

The main aims of the environmental and social impact study were to identify, predict and evaluate all the potential environmental and social impacts due to the proposed solar power plants projects in Telifa site in Amhara regional state. The ESIA study is done with the overall intention of integrating environmental and social concerns into the project's planning, design, construction, and operational stages.

Environmental and social impacts have been identified for both components of the project (solar power plants) in the three proposed project sites in the Amhara region. For all the identified negative impacts mitigation measures were provided alongside the impacts and in some cases, enhancement for positive impacts was also indicated in chapters (see chapters 7, 8, and 9).

A review of international safeguard policies reveals that the major policies triggered relate to Environmental and Social Assessment, biodiversity, and ecosystem services (Tana Biosphere Reserve), Labour and working conditions, community health and safety, information disclosure, and stakeholder engagement. Management measures have been proposed and most of these can be easily implemented with available local resources and national policy and legal provisions (e.g., proclamation 1161/2019, proclamation 1156/2019).

10.2. Recommendations

As soon as the project proponent is identified the project implementation schedule covers all project activities. For example, solar panel installations, designation of command areas for irrigation, time, and modalities for compensation for land take should be communicated ahead of time for the Woreda and Kebele administrations as well as for the potentially affected persons. This should be done at least three months prior to the commencement of solar power plant installations. Moreover, the irrigation component of the project needs a clear market networking strategy for economic feasibility, and ecologically sensitive issues such as further enriching Lake Tana and aggravating the Eichhornia invasion should be closely monitored. To avoid any minor conflicts which might delay the project implementation, the potential developer/project proponent should work in tandem with Kebele administrators to establish grievance-handling committees, which will serve as avenues for community members to channel grievances to the project proponent. The potential contractor should also prepare the grievance handling mechanism for the workforce during the construction phase, and this must be monitored by the client or any other responsible body. There should be continuous monitoring of the biophysical and social impacts of the projects so that the developer or any project proponent could draw a lesson for future investments.

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Annexes

Annex 1: Letter of Communication to Regional and Local Government Offices

Annex 2: List of participant and minutes of meeting

Telifa site

Annex 3: List of Registered Pesticides

List of Registered Pesticides (Insecticides) may be used at project sites

No	Trade name	Common name	Approved uses	Registrant
1	Ajanta 72% EC (W/V)	profenofos	For the control of onion trips on onion.	28
2	Bravo 5% EC (W/V)	lambda-cyhalothrin	For the control of stalk borer on maize	28
3	Ethiolathion 5% Dust	malathion	For the control of maize Weevil (Sitophilus zeamays) on stored maize.	18
4	Ethiolathion 50% EC	malathion	For the control of sweet potato butterfly (Acraea acerata) on sweet potato.	18
5	Ethiothoate 40% E.C	Dimethoate	1. For the control of Aphids on field pea. 2. For the control of Russian Wheat Aphid (Diuraphis Noxia) on Barley.	18
6	Hondize 60% EC	Diazinon	For the control of African boll worm on tomato.	28

List of Registered Herbicides that may be used at project

No	Trade name	Common name	Approved uses	Registrant
1	Orozole 25 EC	Propiconazole	For the control of yellow rust and stem rust on wheat.	57
2	Ridom 80% WP	Mancozeb	For the control of late blight on potato.	33
3	Mancodex Super 72 WP	Metalaxyl + Mancozeb	For the control of late blight of potato & Tomato	53

List of Registered Fungicide that may be used in the proposed project site

No	Trade name	Common name	Approved uses	Registrant
1	Agro- 2,4-D amine 720g/l A.E	2,4-D 720 g/l A. E	For the control of broadleaf weeds in wheat, barley, teff, maize, sorghum, and sugarcane.	9
2	Abocel 41% SL	Glyphosate	For the control of grass and broad-leaved weeds on wheat.	51
3	Pallas Super Tm 320 WG	Halauxifen-Methyl + Pyroxsulam	For the control of grass & broad leaf weeds in wheat and Teff.	2
4	Richway 750 WDG	Tribenuron Methyl	For the control of broad leaf weeds in wheat.	15

Impacts of pesticides

Diazinon exposure, whether from ingestion, skin contact, or inhalation can result in nervous system health effects. These effects may include **watery eyes, runny nose, drooling, loss of appetite, coughing, urination, diarrhea, stomach pain, and vomiting.**

Malathion is highly toxic to bees and other beneficial insects, some fish, and other aquatic life. Short-term exposures to high levels of malathion can affect the nervous system causing a variety of symptoms, including **headaches, nausea, dizziness, weakness, cramps, diarrhea**, excessive sweating, blurred vision and increased heart rate

Profenofos can cause cholinesterase inhibition in humans; that is, it can overstimulate the nervous system causing **nausea, dizziness, confusion**, and at very high exposures (e.g., accidents or major spills), respiratory paralysis and death.

Dimethoate can cause **rapid, fatal organophosphate poisoning with headache, sweating, nausea and vomiting, diarrhea, loss of coordination, muscle twitching, and death.**

Lambda-cyhalothrin may cause **irritation to the skin, throat, nose**, and other body parts if exposed. Skin tingling, burning, and prickling feelings, particularly around the face, are unique temporary symptoms of exposure

Impacts of Herbicides

2,4-D Effects that have been reported following oral or dermal exposure to high amounts of 2,4-D include tachypnea, tachycardia, vomiting, leukocytosis, liver and kidney congestion in fatal cases, metabolic acidosis, and neurological effects characterized by sensory and motor abnormalities

Glyphosate has excellent properties of fast sorption in soil, biodegradation, and less toxicity to non-target organisms. However, glyphosate has been reported to increase the risk of cancer, endocrine-disruption, celiac disease, autism, effect on erythrocytes, leaky-gut syndrome

Halauxifen-Methyl - not likely to be carcinogenic to humans

Tribenuron Methyl; Tribenuron methyl has low to moderate acute toxicity via the oral, inhalation, and dermal routes of exposure. It is not a dermal irritant, but was found to be mildly irritating to the eye and is a skin sensitize (*J*

Impacts of Fungicides

Propiconazole is moderately toxic, and it is a skin sensitizer

Mancozeb exerts numerous effects related to the function of the thyroid gland, including **decreases in serum thyroxine (T_4) levels, thyroid peroxidase activity and iodine uptake**, increased production of thyroid stimulating hormone (TSH) and thyroid weight, hyperplasia, and hypotrophy of follicular cells, therefore still be a potential contributor to thyroid disruption in humans and in result adversely affects the developing brain.

Metalaxyl generally is of **low acute toxicity** but is an eye irritant. It has been classified as a Group E carcinogen (, Office of Pesticide Programs (OPP), US EPA,); that is, a chemical showing evidence of non-carcinogenicity for humans.

Annex 4: Laboratory results for soil and water quality test (TSS01)