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GeoScience Consultancy PLC

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

Environmental and Social Impact Assessments for the Proposed Mini-Grid Solar Power Plant Project in Aregawi, Dera Woreda, Amhara Region

Equatorial Power Energy Services Private Limited Company

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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, off-grid electrification is seen as one option by the National Electrification Program 2.0 (NEP 2.0). This is particularly important for Ethiopia's rural settlements, which are often dispersed and inaccessible.

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

Goals and Specific Objectives

As per the Federal Democratic Republic of Ethiopia ESIA Procedural Guidelines of 2003, the purpose of undertaking environmental and social impact assessment is to generate adequate information, which will help the project proponent/developer to avoid, mitigate or manage significant negative impacts. Moreover, the ESIA study is prepared to ensure compliance to the project financer's requirements of the African Development Bank's integrated safeguards system.

Project components and main activities

The mini grid solar systems include the following components: a mounting system that 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.

The Federal Democratic Republic of Ethiopia Environmental Protection Authority

Project alternatives

Several project options were examined to select feasible alternatives considering biophysical, socioeconomic, and technical factors. The alternatives considered were;

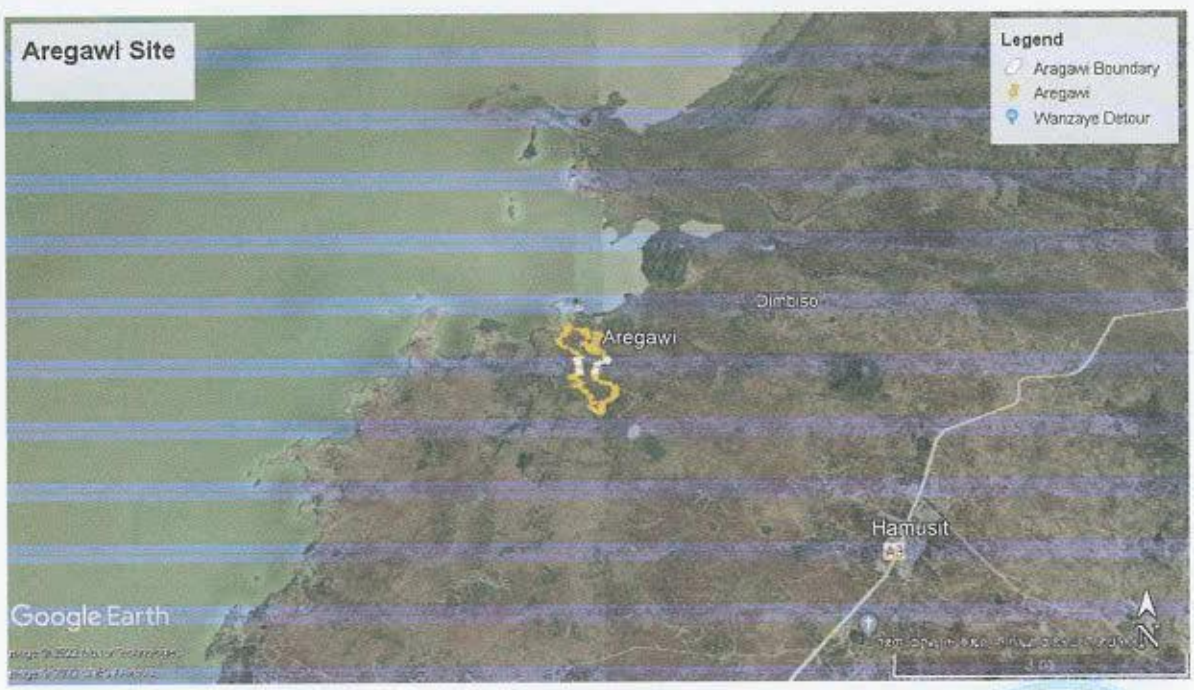
- no project alternative,
- project location alternatives,
- other sources of power (Hydro, Fuel, and Wind): and
- Project implementation option.

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 the Project Area

Project location

The Aregawi site is located at 11.810N and 37.513 E in the south Gondar zone, Dera Woreda, Amhara regional state can be accessed through the Bahir Dar-Gondar asphalted road. To reach the Aregawi site, one must drive along a 7km all-weather gravel road from Hamusit town to the west direction.



Baseline conditions

The Aregawi site and its surrounding are characterized by bimodal rainfall distribution with a main rainy season from June to October and a short rainy season from February to March. Temperature measurements were taken from 06/10-09/10/2021, and the temperature record was 26.34 C for the Aregawi site. The proposed project site is part of the tertiary quaternary volcanic rocks, and lake shore unconsolidated recent alluvial-lacustrine deposits of the quaternary age. The topography of the target area is part of the Fogera plain. The soil in the area is a weathering product of alluvial lacustrine sediments and quaternary and tertiary volcanic as well as organic humus. Soil samples were taken from the site and macro and micro nutrient levels were analyzed. Accordingly, the pH value of the soil in this site is 7.12, which is a very suitable medium of reaction for the availability of primary and secondary macronutrients for plant nutrition. The electrical conductivity result of the current soil is 190µs/cm, which suggests which may be an indication of low concentration of nutrients in the soil due to intensive farming for centuries. The FAO recommended optimal range of electrical conductivity in the soil is 1100µs/cm to 5700µs/cm.

Similarly, the analytical results of exchangeable Na, K, Ca and Mg concentration are 160mg/kg (0.69 meq/100g), 20mg/kg (0.051 meq/100g), 880mg/kg (4.4 meq/100g) and 550mg/kg (5.2 meq/100g), respectively. The concentration of Na and Mg in the target area is medium while that of Ca and K are low. Moreover, the concentration of total Fe is 0.6mg/kg while Mn is 2.9mg/kg. Based on FAO classification, healthy and productive soil should contain from 50 to 1000mg/kg iron and from 20-200mg/kg manganese. Therefore, the concentration of Fe and Mn in the target area is lower than the range of FAO essential nutrients concentration in soil and needs some level of nutrient interventions.

The major rivers in the project areas are Gumera and Bidara. Gumera flows towards the west and finally joins Lake Tana. The groundwater potential appears to be high at all sites. Many people in Aregawi village use Gumera River for irrigation. The water sample was taken from Bidira River to determine water quality. As can be inferred from the results below except for Manganese, which exceeds the WHO maximum limits, all other parameters are within the recommended ranges

No	parameters	Unit	Aregawi	WHO maximum limit	Remark
1	Turbidity	NTU	2.33	5	
2	EC	uS/cm	133	2000	
3	pH	[illegible]	6.86	6.5 - 8.5	
4	TDS	ppm	66.6	1000	
5	Nitrate, NO3	mg/l	0.2	10	
6	Total Hardness	mg/l	50	500	
7	Manganese	mg/l	0.12	0.1	Unacceptable

Concerning the vegetation, trees are grown scattered within and around farmlands and homesteads. Indigenous trees such as *Cordia Africana*, *Juniperus* procera, *Croton macrostachyus*, and *Vachellia tortilis* were seen in the area, but Eucalyptus trees are commonly found around the villages. The common domestic animals are cattle, sheep, goats, and donkeys. The common wild animals in the proposed project site include *Corcorous* (spotted Hyena), Porcupine, common fox, crocodiles, apes, and vervet monkeys.

The population in target kebeles such as at Wagra (Aregawi site) is densely settled and lives in closely packed nucleated village houses. In the proposed project areas, the farmers practice both rain-fed and irrigation activities. The main crops grown include cereals (e.g., wheat, teff, etc.) and vegetables, the latter mainly for urban markets. In the proposed project areas only health posts are available, a health center and primary hospital are found in 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 (Grades 9-12). The main sources of water for drinking in the project areas are hand dug and shallow wells. The project site doesn't have access to electricity from the main grid and in some areas, the community uses solar energy for home lighting. Concerning physical and cultural resources, there are several churches and monasteries in Dera Woreda. Most of these are found outside the potential irrigation areas, and solar power plants will provide them with a potential source of power. The ESIA team did not observe any evidence of archaeological/historical

The Federal Democratic Republic of Ethiopia Environmental Protection Authority

heritages that would potentially be affected by the project implementations. Nevertheless, there is a risk that cultural heritage objects are 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

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.

Concerning 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 and approve ESIA reports and issue 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, the Regional Bureau of Agriculture, Irrigation and Pastoral Development, Women's Office, and Mines and Energy were reviewed. Concerning policies, proclamations, regulations, and guidelines issued by the government of Ethiopia and the AfDB, the ones outlined below, *interalia*, are relevant to the proposed projects and were reviewed:

Constitution of The FDRE, the National Energy Policy of Ethiopia, the Water Resources Management Policy, the National Conservation Strategy of Ethiopia (CSE, 1997), the Environmental Policy of Ethiopia (1997), the Ethiopian Women's Policy, the 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. 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. As such, 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 are 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-gri projects include:

- Employment opportunities for skilled and non skilled labor,
- 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 main negative impacts on the bio-physical environment on Aregawi site 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 (ESMMP).

The project's main 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.

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6. Public consultation

The consultation was conducted with woreda officials and local people in the project area. A public consultation meeting was undertaken at the Aregawi site, 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 any reservations about the proposed solar project. The minute of public consultation is annexed to the main report at the end of this document.

Date of meeting: 08/10/2021
Place of meeting: In the meeting place of Aregawi villagers in Aregawi site (Figure 15)
Number of participants: Men 16 Women 7

Name of participant	Issues raised by the participants	Summary of responses to the issue by EIA team
Ato Moges Mebirat (M)	Would this proposed project be like previous ones where people come, study, and go away or do you materialize it?	The ESIA team responded that the intent of this proposed project is to provide energy for domestic consumption and irrigation. It is thus one of the priorities of the government and, hopefully, it will become the most successful project. However, any project needs a detailed feasibility study that incorporates the community's views such as yours. That is why we are here with you now.
Ato Meteke Asmare (M)	Will this solar power plant be used to establish flour mills and other similar services?	The ESIA team explained that as we expressed earlier the main purpose of this project is to install solar power plant for irrigation so that diesel powered irrigation will be substituted by solar generated electric power for irrigation. Nevertheless, it is under the scope of the project in addition to irrigation, schools, churches, health posts, and small businesses (e.g., flour mills) will benefit from electricity production.
Ato Wasu Mitk (M)	He raised two questions: Should this project bring about road infrastructure? And where will the likely position of the mini-grid solar power plant be?	ESIA team responded that road construction is not the primary purpose of this project, but temporary access roads may be opened up during construction phases. Secondly, the exact location of the solar panel is not yet known. This will be done later, and the persons affected will be notified before the commencement of any solar panel related constructions.
Ato Shumet Alamirew (M)	He said that we have seen similar projects in our village before and confirmed their benefits. So, we need to sign an agreement with the owner of this project for its practical implementation in our village. He also added that compensation should be done in a way of substituting lost land rather than cash payment.	In general, there is no need to sign an agreement with the community/ at this time but once the project will get a final decision to start, the community will be part of the project participants. Regarding compensation, the issue will be dealt with by a separate committee consisting of woreda, kebele, local elders and representatives of project affected persons.
Ato Melkamu (M)	This person is a supervisor for agricultural and irrigation activities in the village and he said that "I agree and happy with this project" and at the same time he gave his advice to the team: 1) to push the responsible body to start the project very soon, 2) It is also good to assign a permanent expert to follow the project activities and implementation.	The issue has already been raised by previous participants and the comment is well noted.
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
			Negative	following the relevant government compensation proclamation.	Developer/Regional government	panels is not identified yet
				affected people before the commencement of the project and		
				redress management should be put in place		
			Negative	mandatory speed limits not exceeding 30km per hour	collaboration with Woreda traffic office	training and traffic signposts 40,000Birr
				Educate all drivers and construction site workers on		
				practices		
		Noise Pollution	Low negative	to daytime hours Personal protective equipment	Minigrid Contractor	PPE 30,000 Birr
				be used during construction works		
		Gender- based violence / including Covid 19	Medium Negative	Community sensitization, regular campaigns addressing issues of behavioural change on HIV/AIDS Provision of materials useful for the prevention of HIV/AIDS	Community /woreda office	Costs for GBV etc) 100,000 Birr campaign, PPE etc 25,000 Birr
		Public health and safety	Medium	Provision of training for workers on	Minigrid Contractor	Cost for half day
				policies		30,000 Birr
				Covid19 prevention protocols		
	Disturbed environment	liquid Wastes	Negative	disposed of in accordance with best industry practices. Any heaps		disposal 150,000 Birr
				the compound should be cleared to keep the area neat and clean.		
				The wastewater from sanitary and construction works should be		
				plastered pond or reservoir and can be recycled for construction,		
				after proper filtering and treatment		
		Air pollution	Low Negative	construction should wear a dust mask. Water shall be sprayed on all		included above, for water spray 30,000
				dispersion when necessary		
		Soil erosion	Medium Negative	seasons		up soil is 60,000 Birr
				selected area and reuse it to fill undulating areas		

Phases	Category of impacts	Main Identified Impacts	Impact Significance	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
		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
		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

Phases	Category of Impacts	Main Identified Impacts	Impact Significance	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
			Negative	PV panels, used batteries, shall be disposed of in accordance with		150,000 Birr
	Biophysical Environment	Air Pollution	Low Negative	Workers assigned to the demolition should wear dust Spray water during demolish work	Minigrid Developer	PPE for workers
		Air Pollution	Low	Workers assigned to the masks.	Minigrid Developer	PPE for workers
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)
Contract	Make sure the contractor has prepared	Proponent	Pre-construction phases	Copy of the approved of it	Cost internal to approvals
Social support to vulnerable people	Job opportunities for project-affected people (loss land), Landowners should be compensated as per land is expected to be community individual	Proponent	Throughout operation phase	Interview vulnerable people, field visit, Check the amount of finance	Supervision cost 5,000 Birr
opportunity	on their education preparedness and skill level	Woreda	and annually months	from company human resource office	5,000

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

Parameters to be monitored	Mitigation measures	Responsible	Monitoring schedule	Monitoring indicators	Monitoring cost (Birr)
Impacts on	Excavation work should be done carefully	Contractor	During	Number of discovered	Part of
cultural heritage	prepared chance find procedures				

Grievance redresses 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 and 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 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).

VERITAS

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AC	Alternative Currents
AfDB	Africa Development Bank
ADLI	Agricultural Development Led Industrialization
AIDS	Acquired Immunodeficiency Diseases
dB	decibels
CBD	Convention on Biological Diversity
CEP	Community Engagement Plan
Covid-19	Coronavirus Disease 2019
CRGE	Climate Resilient Green Economy
CSA	Central Statistical Agency
CSE	Conservation Strategy of Ethiopia
DC	Direct Currents
EFCCC	Environment, Forest and Climate Change Commission
EHS	Environment, Health and Safety
EPA	Environment Protection Authority
EIA	Environmental Impact Assessment
ESIA	Environmental & Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
FDRE	Federal Democratic Republic of Ethiopia
GTP	Growth and Transformation Plan
GHG	Green House Gas
IFC	International Finance Corporation
ILO	International Labor Organization
ISS	Integrated Safeguards System
IUCN	International Union for Conservation of Nature
HIV	Human Immunodeficiency Diseases
PHCU	Primary Health Care Unit
PPE	Personal protective Equipment
PPM	Parts per million
PV	Photovoltaic
STDs	Sexually Transmitted Diseases
STI	Sexually Transmitted Infection
TDS	Total Dissolved solids
WB	World Bank
WHO	World Health Organization

1. Introduction

1.1. Background of ESIA study

Ethiopia has shown an impressive two-digit 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 use. 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).

Considering this, solar-powered mini grids are favorably considered 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 ESIA study is therefore 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 and 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 area.
- 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

The Environmental and Social Impact Assessment (ESIA) was conducted between September and October 2021. The 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 discussion 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 evaluate the proposed project in the context of the natural and socio-economic environment of the mini grid pilot sites. 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 sites in October 2021. The team made observations in and around the project sites 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 laboratory 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 projects (off-grid solar power plant) and the end users or communities. The stakeholders were identified by segmenting across the following groups: directly 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. Key informant interviews or focus group discussions were conducted as appropriate. For community (public) consultations we conducted a public meeting including all the community members and social influences (e.g. clergymen, elders) who could potentially be affected by the proposed off-grid solar power plant in the selected project site. The local government administrations at

Dera Woreda and other appropriate government offices (Agriculture, Health, Education, water and energy, culture and tourism, bureau, etc.) were consulted to obtain their concerns and inputs for the success of the proposed project. Community consultations were conducted with local communities in the Amharic language (following AfDB's requirement to conduct consultation in a language the communities are comfortable with) at Aregawi localities. 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 targeting residents of Aregawi communities and thereafter to conduct interviews with community representatives such as community leaders and social influencers. During the consultation, the ESIA team disclosed the project and presented project objectives, the likely benefits, and adverse impacts. Participants were allowed to express their concerns and expectations regarding the project and likely social and environmental impacts that would likely happen during the construction and operation phases of the mini-grid solar power plant project.

1.4. ESIA report structure

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

Project descriptions, such as proposed project locations, justifications, power, and material requirements are presented in Chapter 3. In Chapter 4, details of baseline environmental and social conditions of Aregawi is provided. Chapter 5 presents stakeholder and community consultation findings. Potential environmental and social impacts of the proposed mini-grid solar power plants activities are highlighted 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. Conclusions and recommendations are written in Chapter 10 based on the findings of the ESIA study. Finally, references and annexes are 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 interviews 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 legislation, policies, strategies, and proclamations particularly related to water resources, energy, environmental protection, and others. In addition, the chapter provides a brief discussion of African Development Bank Operational Safeguard, which are pertinent to the proposed projects.

2.1. National Laws, Policies and Strategies

2.1.1. The Constitution of the 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 children's rights states that every child has the right not to be subject to exploitative practices, not to be necessary, nor permitted to perform work that may be hazardous or harmful to their education, health, or well-being.

The right of the public and the community to full consultation and participation as well as to the manifestation 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 a 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 wastage
- 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 the 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 as well as 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), which was developed through a consultation process over the period 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 to 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 in supporting Ethiopia's developing green economy and for reaching 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 production, delivery, and utilization of energy without affecting or threatening the environment and society. One of the policy instruments in this regard is the introduction of mandatory environmental and social impact assessment on new energy and non-energy investment projects to assess the level of environmental 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 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). This 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, which 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). 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 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. This 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. In this same declaration it is 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 also 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 aims at eliminating or, when not possible, mitigating pollution as an undesirable consequence of social and economic development activities. Additionally, it emphasizes that all citizens have a duty and obligation to conserve the environment, human health, biological diversity, and aesthetic worth of the natural world. It further considers other important 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 any 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 intergenerational 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 that are to be implemented by the regional states. The 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 much 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 populations 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, proprietary right to develop the land to be expropriated, provision of substitution 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 eight 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 considered a civil servant if:

a) A person under the age of 18 years
b) Any person who has been convicted by a court of competent jurisdiction for offenses 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
c) A person having no certificate of competence
d) Any person who is unwilling to take an oath of fidelity following 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 labor 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 Organisation 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 waste
- 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 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 to 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 is in possession of a hunting permit".

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

The purpose of this proclamation is to enact comprehensive legislation to regulate the manufacture, formulation, import, export, transport, storage, distribution, sale, use, and disposal of pesticides and other matters by laying down a scheme of control that would minimize the adverse effects that pesticide use might cause to human beings, animals, plants, and the environment. The detailed legislation of pesticides is presented in this proclamation under 37 articles. To mention article 14 of this proclamation states about pesticides registration and the Ministry 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 ads, etc.

In this article under No. 1 and 5, it is stated that no person shall make any import or export of any pesticide without obtaining an import or export permit issued by the Ministry; and under No. 3 (a) of this article, no pesticide consignment shall be imported if it has been manufactured six months from its date of entry into the country. The disposal rule of pesticides is articulated in Article 21 and No 1 of this article 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

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

2.3.4. The Stockholm Convention

The Stockholm Convention 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. Inclusive of Ethiopia, over 150 countries 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 conservation, utilization, and development of soil, water, flora, and fauna resources in accordance with 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 have been 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 (increased 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 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 renamed the 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. The Environment Policy of Ethiopia coordinates appropriate measures, establishes systems, and develops 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, standards, and 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 and approve ESIA reports and issue 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 centre (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 Descriptions

3.1. Project location

The project site is in the south Gondar zone, Dera Woreda, Amhara regional state can be accessed through the Bahir Dar-Gondar asphalted road. To reach the Aregawi site, one must drive along a 7km all-weather gravel road from Hamusit town to the west direction.

FIGURE 1 Location map of project sites

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 sites. 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).

- **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.

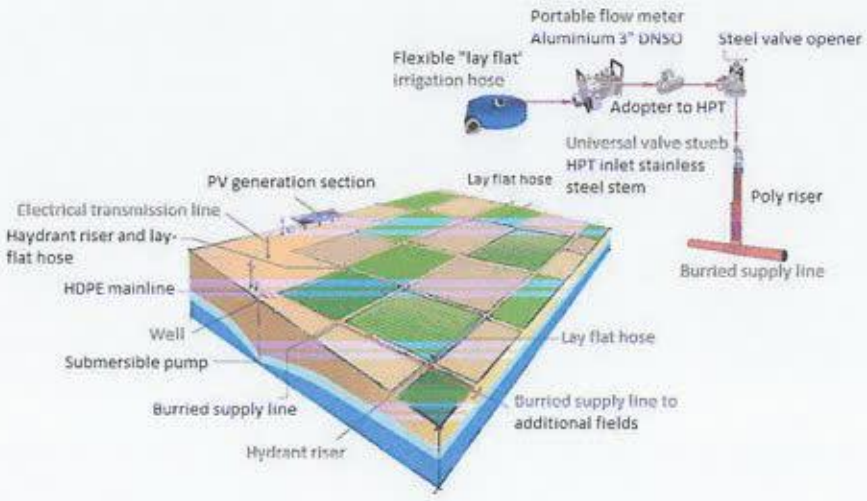

FIGURE 2 Irrigation scheme design

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, building of access roads, fencing, as well as the construction of the light buildings (operation and administration building, security posts, storage, etc.

3.5. Manpower requirements

Installation of solar PVs, and installation of distribution grids are labor-intensive work during the construction phase. As such, it requires 75 skilled and unskilled workers. However, during the implementation phase, manpower requirement is minimal, and it is expected to create 5-7 jobs in the proposed site. Similarly, during the decommissioning phase, about 6 skilled manpower and about 50 laborers 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 houses for temporary workers. During the construction phase, construction machinery such as excavators, dump trucks, mixers, and rollers will be used. used.

3.6. Land requirement

The land required for Solar PV modules installations is 0.15 hectares for the Aregawi site, respectively. The total area required, including internal roads, and light buildings, is estimated to be 0.18 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:

- Construction 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 baseline surveys 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 subsections.

4.1. Physical and biological Baseline Information

4.1.1. Climate: temperature and rainfall

starting from June to October and a small rainy season from February to March (Asmare et al., 2020). The long-term 2400 mm (Lemma et al., 2017). The mean annual rainfall (2006–2013) was 1250–1500 mm in the east where the Dar and 9–24°C in Debre Tabor. In situ measurement of temperature in the field from 06/10-09/102021 was in the measurement (noon or morning) and the presence of cloud cover during measurements.

4.1.2. Geology

In general, the proposed project site is full of volcanic rock of tertiary and quaternary age as well as lake shares 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 sites while the recent quaternary alluvial lacustrine, volcanic, and pyroclasts are found within the specific Aregawi site.

The geology of the Aregawi site is exposed in many places especially following peculiar cinder conic hills made up of pyroclastic scoria and ignimbrites. The main features are pyroclasts, vesicular to aphanitic basalts, and unconsolidated alluvial lacustrine sediments (Figure 3) Specifically, the Aregawi locality contains massive aphanitic basalt underlain by vesicular and patchy phenocrystic lava flow. The basalt is fresh and exists as a relative weathering resistance body and is found above the pyro clast and lacustrine deposits, whereas the vesicular lava flow is dark gray in color, vesicular in texture, and weathered and eroded (Figure 3). The geological features of the area indicate the potential for a good aquifer for underground water sources.

Figure 3 vesicular lava flow, weathered from bottom

4.1.3. Topography and drainage

The project area lies on the southeastern fringe of Lake Tana. The topography of the target area is part of the Fogera plain (Figure 4). Relatively, Aregawi has an undulating topography with randomly distributed cinder conical hills (Figure 4). Field measurements of elevation using GPS at Aregawi site is 1810m. The Bidara River crosses the Aregawi site. The river is used for irrigation as well as for domestic uses, and fishing. The Bidara originates from the Gunna mountains and drain towards lake Tana.

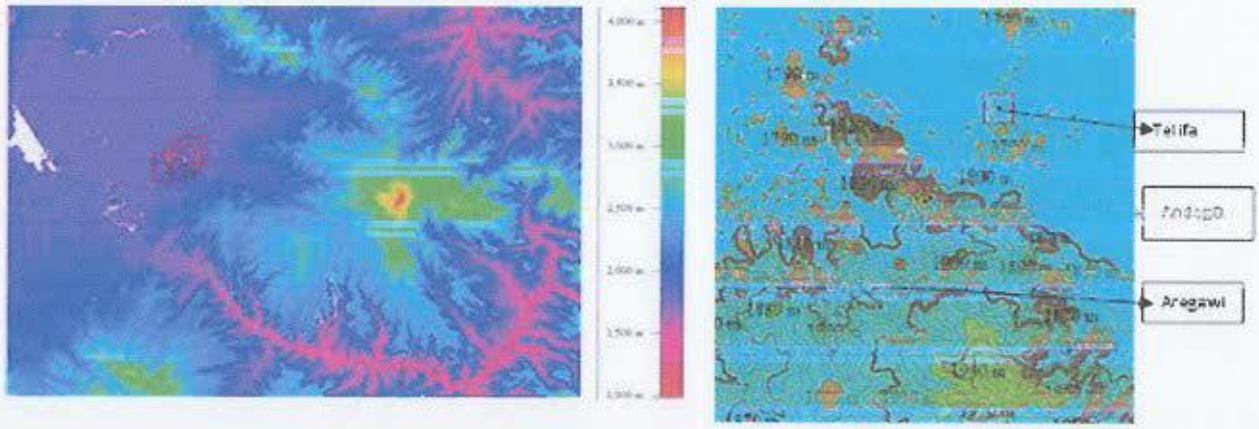

FIGURE 4 Topographic map (above) and photo Partial view of the project area(below)

4.1.4. Soils

Soil forming factors such as parent material, climate, topography, organisms (macro-and micro-organisms), and time play important roles in determining the physical and chemical properties of soils. Among the soil forming factors, climate and organisms are active agents acting upon parent materials and they are modified by the topography over an extended period. Hence, the soils of a given area are a product of the interactions of soil-forming factors. Consequently, the soil in Aregawi area (also in Dera Woreda) is weathering product of alluvial lacustrine sediments and quaternary and tertiary volcanic (parent material), and organic materials that developed over millennia in the wetlands of Tana basin. The soils in the Aregawi area are largely reddish brown in areas of steep and gentle slopes to dark in color with a large content of clay due to the deposition of fine soil particles from the highlands. The types of soils generally vary with the topographic positions predominantly Vertisols and Luvisols in flat and gentle slopes, whereas along a stream there Fluvisols were observed. Generally, the soil is very suitable for annual and perennial cropping. A soil sample was taken from an agriculture field to determine the physical and chemical properties of soil in the laboratory. The soil sample was collected from the surface (0-30cm depth), which was actively used by roots of annual crops

The sample was analyzed in Addis Environmental Services for Water & Waste Water Quality Testing Laboratory in Addis Ababa. The analysis included some macronutrients and micronutrients, and the results were provided in

Annex. As shown in the Annex, the PH, electrical conductivity (EC), macronutrients (Sulfur, Potassium, Calcium, and Magnesium), and micronutrients such as Iron and Manganese are indicated. The pH value of the soil in this site is 7.12, which is a very suitable medium of reaction for the availability of primary and secondary macronutrients for plant nutrition. The electrical conductivity (EC), which is a measure of the soil's ability to conduct electrical currents, is seen as an indicator of nutrient availability or low concentrations. Generally, elevated electrical conductivity indicates the availability of excess nutrients in the soil, while too small, EC indicates a low concentration of nutrients. The FAO recommended optimal range of electrical conductivity in the soil is 1100µs/cm to 5700µs/cm. The electrical conductivity result of the current soil is 199µs/cm, which suggests the low concentration of nutrients in the soil due to intensive farming for centuries.

Similarly, the analytical results of exchangeable Na, K, Ca and Mg concentration are 160mg/kg (0.69 meq/100g), 20mg/kg (0.051 meq/100g), 880mg/kg (4.4 meq/100g) and 650mg/kg (5.3 meq/100g) respectively. The Food and Agriculture Organization (FAO) of the United Nations provided a range of values for the interpretation of exchangeable cations in the soil. However, FAO cautioned its classification) for each nutrient should not be considered in isolation but about the other ions present in the soil, the rate of its movement to the plant roots, which is determined by soil texture, soil moisture, status, and nature of cation (Roy et.al., 2006) and this classification is presented in the table below. Based on the information in Table 1 and appendix below, the concentration of Na and Mg in the target area is medium to low, respectively, while the concentration of Ca and K are low. Similarly, as indicated in appendix 1, the concentration of both sulfate and sulfur in the sample is nil. According to FAO, the standard concentration of sulfur in soil ranges from 500mg/to kg-5000mg/kg. Therefore, laboratory results reveal that the concentration of sulfur in the area is not detected. It's very low compared to the standard ranges of FAO.

Moreover, the concentration of total Fe is 0.6mg/kg while Mn is 3.9mg/kg correspondingly. Based on FAO classification, healthy and productive soil should contain from 50 to 1000mg/kg iron and from 20-200mg/kg manganese. Therefore, the concentration of Fe and Mn in the target area is lower than the range of FAO essential nutrients concentration in soil and needs modification. In general, the laboratory result indicates that the concentration of macronutrients and micronutrients in the area is very low.

TABLE 1: RANGES OF EXCHANGEABLE CATION (CMOL/KG=MEQ/100G) IN SOIL FOR INTERPRETATION OF CATION EXCHANGE DATA (ROY ET AL., 2006)

Rating	Exch. Ca	Exch. Mg	Exch. K	Exch. Na
Very high	>20	>8	>1.2	>2
High	10-20	3-8	0.6-1.2	0.7-2
Medium	5-10	1-3	0.3-0.6	0.3.-0.7
Low	2-5	0.3-1	0.2-0.3	0.1.-0.3
very low	<2	<0.3	<0.1	<0.1

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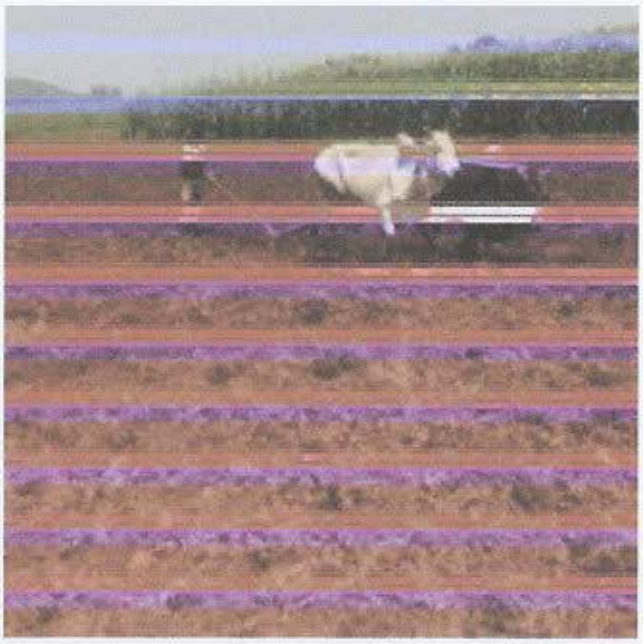

FIGURE 5 Soil sampling sites at Aregawi

4.1.5. Water Resources

4.1.5.1. Surface water

The major river in the project area is Bidira which is the major river that flows east to west and finally joins Lake Tana. It is a perennial river flowing throughout the year and is about 20-meter width. Most people in Aregawi village use Gumera River for irrigation. Water sample is taken from Bidira river and analyzed; the result is presented in the following table.

TABLE 2: SELECTED PARAMETERS OF WATER QUALITY TESTS FOR AREGAWI

No	parameters	Unit	Aregawi	WHO maximum limit	Remark
1	Turbidity	NTU	2.99	5	
2	EC	uS/cm	133	2000	
3	PH	log10	6.96	6.5- 8.5	
6	Total hardness	mg/l CaCo3	65	300	
7	Manganese	mg/l	0.12	0.1	Unacceptable

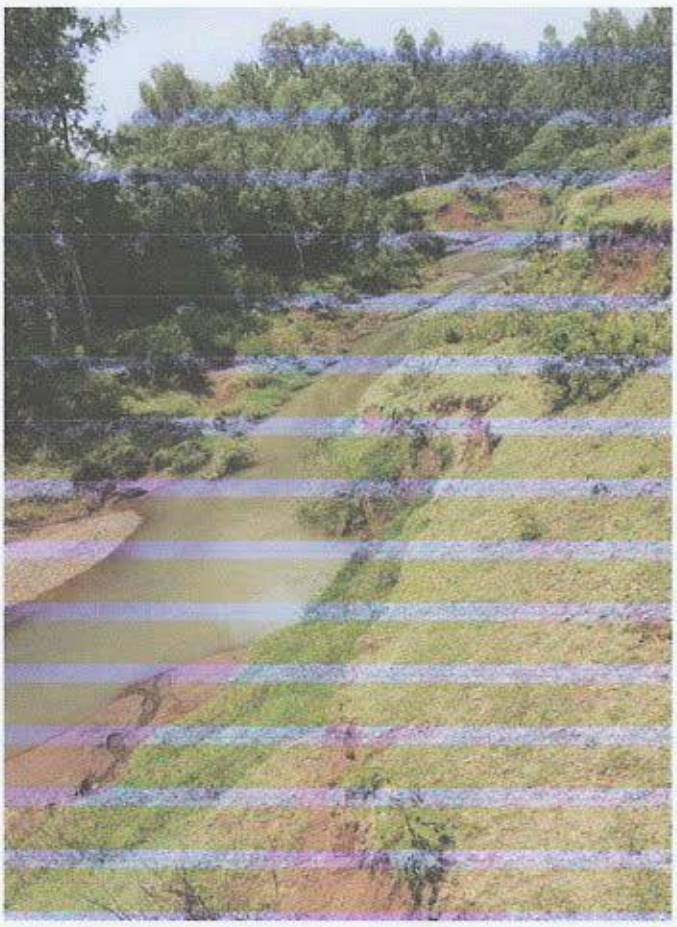

FIGURE 6 BIDIRA RIVER

4.1.5.2. Groundwater

The Dera woreda largely depends on the ground water source for domestic and irrigation water supply. According to 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 range from 130 to 408 m.

4.1.6. Noise baseline condition

During the construction phase, some noises could be generated from construction machinery (like excavators, loader, bulldozer, mixers, dump trucks, compactors, generators, etc.) movements. This may disturb 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 of time and is not expected to cause a significant nuisance to the public, at least not with standard mitigation measures in place.

TABLE 3: NOISES, AND TEMPERATURE MEASUREMENT RESULTS OF AREGAWI SITE AND NEARBY TOWN

Site	Location UTM	Elevation in m	Station	CO in ppm	Temp in C0	Noise in dB			Time	Date
						Max	Min	Av.		
Aregawi	338258E 1305810N	1837	AW001	0	26	76.2	37.8	57	8:05	6/10/2021
Aregawi	333771E 1306034N	1809	AW002	0	33	68.3	43.4	55.85	11:20	6/10/2021
Hamusit	343061E 1302693N	1937	AW003	0	34	99.8	63.1	81.45	12:58	6/10/2021

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 implementations.

The average field air quality measurement for Aregawi and the nearby small town is presented in Table 4. For both Aregawi and Hamusit fine particulate concentration is not of concern (all values below 0.075 PP), hence recommended good quality. However, the coarse particulate matter concentration (PM 010) for Hamusit town is slightly higher (0.09 ppm).

TABLE 4: AIR QUALITY MEASUREMENT RESULTS AT AREGAWI SITE AND NEARBY TOWN HAMUSIT

Site	Location UTM	Elevation in m	Unit	CO	PM2.5			Pm10			Time	Date
					Min	Max	Av	Min	Max	Av		
Aregawi	338258E 1305810N	1837	ppm	0	0.031	0.033	0.032	0.034	0.041	0.037	7:50	6/10/2021
Aregawi	337371E 1306034N	1809	ppm	0	0.017	0.026	0.023	0.02	0.04	0.03	11:15	6/10/2021
[illegible]	[illegible]	[illegible]	ppm	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Generally, the PM2.5 ranges from 0.002 to 0.032 which is not too beyond the WHO required standards. Moreover, CO concentration was nil in the proposed site.

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.

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