

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

Environmental and Social Impact Assessments for the Proposed Mini-Grid Solar Power Plant Project in Murche, Arbaminch Zuria Woreda, Southern Nations, Nationalities and Peoples Region (SNNPR)

October 2023

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Executive summary

1. Introduction

RVE.SOL ETH Energy Generation Solutions PLC is a solar company newly incorporating in Ethiopia. RSEL intends to deploy Solar mini-grid solutions in Murche, Arbaminch site in Zuria Woreda, Southern Nations, Nationalities and Peoples Region (SNNPR) in line with the DREAM projects described herein.

RVE.SOL ETH Energy Generation Solutions PLC is a subsidiary of RVE.SOL Soluções de Energia Rural, S.A., a global solar developer with its headquarters in Leiria, Portugal. Expansion of the company to Ethiopia will begin with 2 pilot projects under the DREAM project and in close partnership with the relevant Ethiopian Ministries.

1.1 Overview of the project

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

The DREAM project has proposed Murche village in Genta Kenchema Kebele, Gamo Zone, for mini-grid and irrigation system development in SNNP region. The size of the mini grid is currently estimated to be around 450 kW in Murche. The potential deviations in size estimates will not have a significant impact on any of the ESIA recommendations. The mini grid, which is stand-alone AC coupled solar photovoltaic (PV) systems, will provide reliable power supply to the community and to an irrigation system which will replace the diesel pumps currently used by farmers for irrigation. Once completed, the Project is expected to go into commercial operation in September 2023 and supply electricity to smallholder farmers for irrigation purposes. Minigrid system project components and project impacts were assessed, identified, and addressed in this Environmental and Social Impact Assessment (ESIA) report in this Environmental and Social Impact Assessment (ESIA) for Murche, Arbaminch site in Zuria Woreda, Southern Nations, Nationalities and Peoples Region (SNNPR)

Goals and Specific Objectives

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

Project components

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.

Project Alternatives

Several project options were examined to select the feasible alternative considering biophysical, social, economic, and technical factors. The alternatives considered are as follows:

- There were no project alternatives,
- project location alternatives,
- other sources of power (Hydro, Fuel, and Wind), and project implementation options.

Based on technical feasibility, economic viability, and environmental acceptability, solar energy was selected because of the numerous project advantages it can present to the local community, low negative impacts of the project on the social and biophysical environment.

3. Description of the project area

Murche is located at 5°54'N 37°27'E, about 26 km south of Arbaminch city in Southern Nations, Nationalities and Peoples regional state. It can be accessed through an asphalt road leading from Arbaminch to Konso. It takes a right turn from Genta Kenchema Kebele administration center and a drive towards west about 10 kms on a dry weather road.



4. Baseline Conditions

Murche experiences a double maxima rainfall regime. The mean annual rainfall recorded for the nearest Arbaminch meteorological station (at 1200 m.a.s.l) is about 900 mm whereas the mean annual temperature is 25⁰c. The geology of the Murche site falls under the main Ethiopian rift formations where pre-and post-rift volcanic deposits dominate the parent material. The dominant rocks exposed in the nearby surface include welded tuffs and ignimbrites. As such the soils are weathered products of the rift related pyroclastic flow and alluvial lacustrine deposits. The latter is predominant in Murche site owing to its location along the shore of Lake Chamo. Soils samples were collected from the Murche site and analysis were conducted to determine the soil fertility status. Parameters included pH, electrical conductivity (EC), macronutrients (Sulfate, Sodium, Sulfur, Potassium, Calcium and Magnesium) and micronutrients (Iron and manganese). The pH value of the soil in this site is 7.61 suggesting that the soil in the area is a slightly alkaline soil type that developed mostly in drier areas. The electrical conductivity result of the soils in Murche is 219 μ s/cm which suggests the low concentration of nutrients but with slight risk of salinization in the future. The FAO recommended optimal range of electrical conductivity in the soil is 1100 μ s/cm to 5700 μ s/cm. In the same connection, the laboratory tests for Na, K, Ca and Mg are 140mg/kg (0.6 meq/100g), 70.3mg/kg (0.20 meq/100g), 1220mg/kg (6.1 meq/100g) and 460mg/kg (3.8 meq/100g), respectively. The concentration of K is low while that of Mg appears to be higher. Similarly, the concentration of both sulfate and sulfur in the samples are 210mg/kg and 70mg/kg respectively which is below the FAO recommended values 500mg/kg-5000mg/kg.

Furthermore, the laboratory results indicated that the concentration of total Fe and Mn are 0.5mg/kg and 0.8mg/kg respectively. 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. The laboratory test result revealed that the concentration of

shows some degree of deficiency and hence requires some level of treatment.

The natural vegetation has already been cleared for farming, but the remnant trees indicated that it was once dominated by woodland or wooded grassland (e.g., *Balanites aegyptica*, *Terminalia brownie*, etc). Nevertheless, endangered or threatened species were not observed around the Murche site. A drinking water sample was collected from the deep well, which is currently being used by the community and sent to a laboratory for physicochemical analysis. The results show that only sodium concentration and turbidity are beyond the WHO maximum limit for drinking water in Murche. Socio-economically the local people depends on agriculture of their livelihoods. Irrigated agriculture plays a dominant role due to its proximate location to Lake Chamo and the Sille river follows crossing farms. Hence, the local people produce banana and supply it to the nearby Arbaminch city and beyond. Migrants from the Gamo highlands and the neighboring labor surplus area such as Wolaita dominate the seasonal labour market for irrigated agriculture. Regarding health facilities there is one referral hospital, 4 health centers, and 26 health posts and several clinics in and around Arbaminch city but Murche site does not have any good health services providers except they travel to over 15 kms to Arbaminch. Regarding education services, in Murche village, there is only one elementary school hence after completing elementary school, need to travel to Arbaminch, which is about 15 km from the Murche village. In addition, there is no electricity supply since it is not connected to the national grid.

5. Institutional and Legal frameworks

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

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

Regarding the policies, proclamations, regulations, and guidelines issued by the government of Ethiopia and the AfDB, the ones outlined below, *inter alia*, are relevant to the proposed projects:

Constitution of The FDRE, National Energy Policy of Ethiopia, Water Resources Management Policy, National Conservation Strategy of Ethiopia (CSE, 1997), Environmental Policy of Ethiopia (1997), Ethiopian Women's Policy, Health Policy of Ethiopia, Environmental Impact Assessment (Proclamation No. 299/2002): Environmental Pollution Control (Proclamation No. 300/2002), Public Health Policy (Proclamation No. 200/2000): in addition, the ESIA team has also reviewed the African Development Bank Operational Safeguards Policy.

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

- **OS1 Environmental and Social Assessment:** This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements. The proposed projects are Category 3 projects as they are less likely to have site-specific environmental and/or social impacts. Likely negative impacts are site-specific, largely reversible, and readily minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards.
- **OS2: Involuntary Resettlement: Land Acquisition, Population Displacement, and Compensation:** This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on

effectiveness of those requirements. As the risk category of the project falls under category 3 the project does not trigger OS 2 and hence resettlement action plan and livelihood restorations are not needed.

- **OS3: Biodiversity and Ecosystem Services:** The overarching objective of this safeguard is to conserve biological diversity and promote the sustainable use of natural resources. This safeguard could be triggered due to trade-offs of ecosystem services where the availability of solar energy may result in increased withdrawal of water for irrigation (to increase agricultural production) at the cost of regulatory services such as draining wetlands which are carbon sinks and biodiversity hotspots.
- **OS4: Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials, and Resource Efficiency:** This safeguard covers the range of impacts of pollution, waste, and hazardous materials for which there are agreed on international conventions and comprehensive industry-specific standards that other multilateral development banks follow. The solar mini-grid power plants are meant to curb pollution which is already underway through diesel pumps for irrigation. 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 the site.
- **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 labor. Construction and decommissioning of mini-grid power plants and irrigation facilities may temporarily attract a medium sized labour force. Unfortunately, workers may not be properly informed of their rights and work conditions.

6. 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-grid project includes:

- 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 risks of contamination of water and soil from the disposal of hazardous wastes (including PV panels) in Sille stream are high. Increased water consumption for cleaning the solar panels is among the few adverse impacts of the proposed mini-grid solar power plant project. However, most of the above potential impacts are minor or moderate and their impacts could be avoided or mitigated through proper implementation of the proposed Environmental and Social Management and Monitoring Plan (ESMP)
- 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, a 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 involve an external labor force.
- Finally, fire hazards, workplace accidents, injuries, and traffic accidents to workers and local communities were among the identified negative impacts of the proposed mini-grid solar power project during the construction and decommissioning phases of the project.

7. Public consultation

Consultation was conducted with Woreda officials and local people in the project area. Public Consultation meeting was undertaken in the proposed project sites during which the attitude of the community was assessed. It was very helpful to obtain basic information on socio-economic, sociocultural, and biophysical impacts of the project, and the associated measures to be taken. The discussion was participatory, in which the participants have expressed their views, concerns and suggestions without any reservation on the proposed solar and irrigation project. The public consultation minutes is annexed to the main report of this document.

Name of participant (anonymous)	Issues raised	Responses by the ESIA team
Person 1	We live in "a darkness" for so many years and so long. Can this project provide us with electricity?	The ESIA team explained that providing energy for irrigation and household electricity is the prime purpose of this project. If this solar grid power plant project financed, it will provide electric power for household consumption and irrigation
Person 2	Our crops such as maize and banana are drying out due to lack of diesel and pumps for irrigation water, for at least three months a year. Can this project provide the community with electric pump for sustainable supply of water?	If the project succeeds it would give communities with a reliable energy for irrigation
Person 3	There are no good health facilities in Murche especially women and children suffer from birth complications and malaria infestations. Will this project provide health services to the community?	The ESIA team responded that the purpose of this project is to provide a reliable supply of energy for irrigation and household consumption. However, PV panels can be installed in the existing health center and better health services may be expected.
Person 4	Does the government pay compensation for land taken for Panel construction?	The ESIA team responded that the government pays appropriate compensation for any land intake before the commencement of the project.
Person 5	Does this project intend to dig wells for drinking and irrigation purposes?	Probably yes, but other separate team will answer this question.
Person 6	Who will pay for the compensation of land taken away permanently for solar panel construction?	Compensation is usually paid by the government. There will be a separate committee established for this purpose which will likely involve representatives from the community
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

5. Environmental and Social Management Plan (ESMP)

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	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
Construction Phase	Human environment	Public Health	Conduct public health awareness campaigns addressing issues of behavioural change, HIV/AIDS, etc.	Community/ Woreda Labour and Women Affairs office	Awarenessraising and training 25,000 birr
			Prepare training manual and conduct regular training about STD's.		For internal half day training 15,000 birr
		COVID 19	Workers shall follow strictly Covid19 prevention mechanisms such as temperature measurement at the gate of the compound, washing of hands, wearing of masks, avoid hand shake, and keep social distance as much as possible.	Minigrid Contractor /EHS unit of the project proponent	30,000 birr for the purchase of PPE
		Gender- based violence/ child labour	Provision of training for workers and families, Community sensitization, regular monitoring for EHS compliance	Woreda labour and women's affairs office	100,000 for training, and regular monitoring
		Impacts on cultural, historical and archaeological site	If, in case, something new finds is suspected to be religious or historical site during excavations work, Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of construction procedure manual	Minigrid Contractor supervised by SNNP regional state culture and tourism office	Supervision cost 20,000 birr

Phases	Category of impacts	Main Identified Impacts	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
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Biophysical environment	Generation of solid Waste	<p>Hazardous waste, including broken PV panels, shall be disposed of in accordance with best industry practices.</p> <p>Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean.</p> <p>Solid waste from packaging materials like fertilizer & seed bag should be disposed of at appropriate place. Bottles and containers of pesticides and herbicides should be stored and removed following best industrial practices</p>	<p>Minigrig Contractor</p> <p>Woreda agricultural office</p>	Estimated cost for disposal of solid waste 40,000 birr
	Generation of liquid Waste	<p>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.</p> <p>The wastewater from sanitary and construction works should be collected through a channel in a plastered pond or reservoir and can be recycled for construction, green area, and other purposes after proper filtering and treatment. Very minimal amount of wastewater for Minigrig, very limited amount of fuel or hazardous material</p>	Minigrig Contractor	For construction of plastered pond and other storage structure is 60,000
	Noise Pollution	<p>Noisy activities shall be scheduled to daytime hours</p> <p>Personal protective equipment such as ear mufflers/plugs should be used during construction works</p> <p>Noise disturbance and impact can be reduced by also administration and management deciding to work on a shift basis, work rotation and work time reduction for workers to reduce workers exposure to noise, etc.</p> <p>Personal protective equipment such as ear mufflers/plugs should be used</p>	Minigrig Contractor	Cost of purchase of PPE included above.
	Air pollution	<p>Workers assigned in the construction should wear a dust mask. The supervisor should strictly follow and make sure this procedure is in place before starting their job, and Water shall be sprayed on all internal roads to minimize dust dispersion when necessary</p>	Minigrig Contractor	PPE included above, and water spray is 20,000 birr
	Soil erosion	<p>Avoid excavation during the rainy seasons</p> <p>Heap the excavated soil in the selected area and reuse it to fill undulating areas</p>	Minigrig Contractor	Labour cost to pile up soil is 30,000

Phases	Category of impacts	Main Identified Impacts	Mitigation Measures/enhancement	Responsible bodies	Estimated cost
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		Impacts on Fauna and Flora	Restrict activities to allocated construction areas only Prohibit hunting at any time and under any condition by construction workers on site Replantation of indigenous trees in the selected area	Minigrad Contractor and Woreda Agriculture office	Tree planting and seedling 40,000 Birr
Operat ion Phase	Human Environment	Occupational health and safety	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	Minigrad Developer	Estimated cost to purchase lifetime PPE is 60,000 birr
		Fire hazards	The solar PV plant should be equipped with proper fire extinguishers. The technician should regularly inspect Solar PV components	Minigrad Developer	Fire protection systems 40,000
		Impacts on cultural, historical and archaeological site	If, in case, something new finds is suspected to be religious or historical site during excavations work, Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of construction procedure manual	Contractor, supervised by SNNP regional state culture and tourism office	No cost is implied
	Biophysical Environment	Liquid waste	Construct a toilet inside the power site premise and collect sanitary waste and finally dispose it off at permitted area when needed	Minigrad Developer	No cost implied here since toilets/septic tank will be constructed during the construction phase
		Loss of farm and grazing land	Landowners shall be compensated as per the new proclamation No. 1161/2019 before the construction activities started	Minigrad Developer, Woreda Agriculture offices, Woreda administration	The cost will be estimated later by Woreda experts
Decom missioning phase	Human Environment	Gender-based violence/Child labor	Provision of training for workers and families, Community sensitization, regular monitoring for EHS compliance	Community / Woreda labour and women's affairs office	20,000 for training, and regular monitoring
		Loss of employment	Transfer permanent workers to other active projects or be absorbed into other government offices Pay compensation (severance) fee for permanent workers	Minigrad Contractor/Regional government	Compensation payment for workers should be paid by the Minigrad Contractor TBD
Phases	Category of impacts	Main Identified Impacts	Mitigation Measures/enhancement	Responsible bodies	Estimated cost

	Biophysical Environment	Generation of solid Waste	Hazardous waste, including broken PV panels, used batteries, shall be disposed of in accordance with best industrial practices	Minigrig Contractor	Waste disposal cost 150,000
		Air Pollution	Workers assigned to the demolition should wear dust masks. Spray water during demolish work	Minigrig Contractor	PPE purchase and water spray cost 40,000
Total					670,000

9. Environmental and Social Monitoring Plan (ESMP)

ESMP has been prepared for addressing all adverse impacts pertaining to the implementations of the mini-grid and irrigation projects. The ESMP presents in detail parameters to be monitored, 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 largely 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 construction phase that they are required to act as agreed on the contract document and this ESIA study. The Federal Environmental Protection Authority is the regulatory body responsible to review ESIA, monitor, audit, enforce and guide its implementations.

Parameters to be monitored	Mitigation Measures	Responsible for monitoring	Monitoring schedule	Monitoring indicators	ESM cost in ETH Birr
Contract management	Make sure the contractor has prepared ESMP for approval by the client	Proponent	Pre-construction and construction phases	Copy of the approved ESMP and implementation of it	Cost internal to developer to get approvals
Social support to vulnerable people	Job opportunities for project-affected people (loss land), Landowners should be compensated as per proclamation No. 1161/ 2019.	Proponent	Throughout operation phase Note: selected land is expected to be community land, not individual	Check the amount of money paid out from finance	Supervision cost 5,000 birr
Employment opportunity	Hire workers from local people depending on their education preparedness and skill level	Proponent & Woreda	At the beginning and annually	Number of local workers from company human resource office	Supervision cost 2,000

Parameters to be monitored	Mitigation Measures	Responsible for monitoring	Monitoring schedule	Monitoring indicators	ESM cost in ETH 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 5,000

Liquid waste	<p>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</p> <p>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</p>	proponent	Beginning of construction and annually each year of Operation	<p>Annual check that the necessary are in place</p> <p>Constructed plastered pond/ reservoir if required</p> <p>Amount of water recycled</p>	Supervision cost 5,000k to be done in conjunction with above annual visit
Noise pollution	<p>Noisy activities shall be scheduled to daytime hours</p> <p>personal protective equipment such as ear muffers/plugs will be used</p>	Proponent in collaboration with Woreda health experts	Weekly during the construction phase	Noise level should not exceed the world bank standard (55dBA and 45 dBA during the day and night times, respectively)	Cost for regular checking of noise level 5,000
Air pollution	<p>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</p> <p>Water should be sprayed on all internal roads to minimize dust dispersion when necessary</p>	proponent collaboration with Woreda health experts	Periodically during the construction and operation phase	<p>Check air quality measurement, Air emission shouldn't exceed WHO standards</p> <p>Supervise workers proper use of PPE's</p> <p>Complaints from the local governor, community</p>	Expert cost for regular check emission level 5,000 to be done together with noise checks
Loss of farm and grazing lands	<p>Landowners should be compensated as per the new proclamation No. 1161/2019 before the construction activities started</p> <p>Provide priority to a job opportunity for those projects affected people (PAP) during construction and implementation phases</p>	Proponent	Before commencement of construction work	<p>Check the amount of money paid for PAP</p> <p>Contractor's personnel office documentation</p>	No cost
Parameters to be monitored	Mitigation Measures	Responsible for monitoring	Monitoring schedule	Monitoring indicators	ESM cost in ETH Birr
Traffic accident	<p>Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages)</p> <p>Mandatory speed limits not exceeding 40km per hour</p> <p>Collaborating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)</p>	Proponent collaboration with Woreda traffic police	Every three months during construction, annually during operations	<p>Number of accidents on the site</p> <p>Speed limits put at appropriate places</p> <p>Erected traffic sign</p>	Supervision cost 2000, to be done together with above checks
Sexually transmitted diseases like HIV	<p>Health promotion: sensitization of both community and workforce</p> <p>Provision of materials useful for the prevention of HIV/AIDS</p> <p>Having in place appropriate signposts to educate the workforce and community about the Project's HIV policy</p>	Woreda health office	Every month during the construction and operation phase or as determined by the local health office	<p>Number of distributed condoms</p> <p>Check the number of trainings conducted</p>	Training cost 100,000

Covid 19	<p>Train workers to follow strictly Covid-19 prevention mechanisms</p> <p>Temperature measurement checkup each day at the gate of the compound</p> <p>Provision of materials necessary for prevention and detection of COVID 19</p>	Proponent in collaboration with Woreda health experts	Regularly during construction and operation	Number of infected people with covid 19	<p>Expense already included in construction and operations.</p> <p>No cost to report # of cases.</p>
Occupational Health and safety	<p>Use of appropriate PPE during installation and maintenance</p> <p>The solar mini-grid plant shall be equipped with a fire-fighting system</p> <p>Ensuring all electrical equipment and machinery are properly grounded</p>	Proponent	Regularly during construction and operation	Total recordable incidence rates	For the provision of first aid a lump sum of 5,000
Fire hazards	<p>The solar mini-grid plant should be equipped with a fire-fighting system</p> <p>The technician should regularly inspect Solar PV components</p>	Proponent	Every three months during the construction and operation phase	Number of incidents and reported cases	Part of project and operation cost
Total Minigrid Developer / Contractor Only					34000
Total other parties					100000
Total Monitoring					134,000

10. Grievance redress mechanisms:

It is expected that no major grievance issue will arise. However, to ensure that stakeholders have avenues for redressing their grievances related to any aspect that may result from the project, procedures of 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, brief description of issue, proposed corrective actions, and date of response sent to the complainant
- All grievances will be registered and acknowledged within 6 working days then responded to within 15 days. All responses will be done either in writing or verbally, according to the preferred method of communication of the complainant.

11. Roles and responsibilities

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

approximately 15,000 USD (assuming 1USD = 53.65 Birr).

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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 Labour 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	Photo Voltaic
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 uses. To meet the rising demands of energy for development and meet the challenges of climate change, Ethiopia designed the Climate Resilient Green Economy strategy (CRGE). This strategy was well aligned with Ethiopia's ambitious plan to become a lower-middle-income country by 2025 (GTP II). The alignment of the two policies (GTP II and CRGE) is instrumental for Ethiopia's broad economic planning and has proven to be particularly central in the design of Ethiopia's power development strategy (Veritas, 2020). The same document stipulates that mini grid 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).

Given 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 project. The purpose of the 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 impacts 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 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 project potential impacts are clearly identified and the corresponding mitigation measures are appropriately addressed before decisions are made to implement the project.

Specifically, the ESIA study is to:

- Establish the baseline conditions of the project areas.
- Assess and report on the likely magnitude and significance of impacts, both positive and negative ●
Conduct stakeholders and community consultations
- Propose mitigation actions to reduce negative impacts and enhancement mechanisms for positive impacts

- Propose ESMP and a monitoring plan for significant impacts.

1.3. Approaches and Methods

1.3.1. General

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

1.3.2. Review of relevant documents

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

1.3.3. Field Survey

Field surveys and observations are critical to understanding the likely impact of a given project on the environment. The ESIA study team conducted a field survey of the project site in October 2021. The team made observations in and around the project site and gathered essential field data. During site observations, information on physical, biological, and socioeconomic environments has been collected. In addition, noise level, air quality, carbon monoxide, and ambient temperature measurements were conducted. Moreover, the team has also collected soil and water samples and subjected them to physio-chemical analysis in the 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 stakeholders' consultations. First, we identified and mapped potential stakeholders (details are provided in section 5.2) based on the nature of the project (e.g., off-grid solar power plant) and the end users or communities. The stakeholders were identified by segmenting across the following groups: directly and indirectly affected persons, institutional stakeholders including government and organizations likely to be involved in project implementation, regulation, and monitoring.

Following stakeholders' identification, we separately engaged the relevant government offices. Official letter communications were made to all the identified government offices and then key informant interviews or focus group discussions were conducted as appropriate. For community consultations we carried out focus group discussions at the proposed project site in Murche. The focus group constituted of local resource users (farmers), church leaders, elders, youth, and women. The above segment of the community is thought to be directly affected by the proposed mini-grid solar power plant project. Moreover, church leaders and elders can exert influence on the community and hence of vital importance for the successful execution of the project. Whereas local government administrations from Gamo Zone and Arbaminch Zuria woreda and appropriate local 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 Gamo languages and local assistants made translations to the ESIA team (following AfDB's requirement to conduct consultation in a language the communities are comfortable with) at Murche locality. The

community level stakeholder engagement activities targeted entire communities within the project's area of influence including the indirect impact zones. Two approaches were adopted at this level, the first was to have general community meetings targeting residents of Murche and thereafter to conduct interviews with community representatives such as community leaders and social influencers. During the consultation, the ESIA team has disclosed about the project and presented project objectives, the likely benefits, and adverse impacts. Then after participants were allowed to express their concerns and expectations regarding the project and likely social and environmental impacts that would likely happen during construction and operation phases of the mini-grid solar power plant project.

1.4. ESIA report structure

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

Project descriptions such as proposed project location, justifications, power, and material requirements were presented in Chapter 3. In Chapter 4, we present the details on baseline environmental and social conditions of the proposed project area. After having established the baseline environmental and social conditions. We present details of public consultations in Chapter 5. Potential environmental and social impacts of the proposed mini-grid solar power plant activities are presented in Chapter 6; this is followed by discussions of project alternatives in Chapter 7. Chapters 8 and 9 present the proposed ESMP and monitoring plans, respectively. Chapter 10 offers our conclusion and recommendations, based on the findings of ESIA study, were presented. Finally, references and annexes are provided at the end of the document.

1.5. Limitations

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

2. Policy, Legal and Administrative Frameworks

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

2.1. National Laws, Policies and Strategies

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

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

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

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

expression of their views in the planning and implementation of Environmental Policies and development projects that affect them is enshrined in the constitution (Articles 92.3 and 43.2).

2.1.2. National Energy Policy of Ethiopia

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

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

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

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

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

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

The Federal Government of Ethiopia has undertaken several initiatives that aim to develop regional, national, and sectoral strategies to conserve and protect the environment. One of these strategies was the conservation strategy of Ethiopia (CSE, 1996). This document provides a strategic framework for integrating the environment into new and existing policies, programs, and projects. It is also an important policy document, which views environmental management as an important component of development. It recognizes the importance of incorporating environmental factors into development activities from the outset.

The major environmental and natural resources management issues facing Ethiopia are well documented in the CSE (FDRE, 1997). The CSE sets out detailed strategies and action plans as well as the institutional arrangements required for the implementation of sectoral 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 that will support 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 the production, delivery, and utilization of energy without affecting or threatening the environment and society. One of the Policy Instruments in this respect is the introduction of mandatory environmental and social impact assessment on new energy and non-energy investment projects to assess the level of emissions of pollution and determine whether the project will have to be realized and on the type of necessary mitigation measures to be adapted.

2.1.7. National Social Protection Policy of Ethiopia

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

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

2.1.8. Ethiopian Women’s Policy

The 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 of women on the socio-economic development of the nation. Second, the policy gives special attention to eliminating all forms of discrimination against women and creating awareness of women’s legal rights. Finally, it was intended to create the appropriate structures within the government offices to establish and monitor the implementation of different gender-sensitive and equitable public policies. Following the policy recommendations of creating an appropriate institutional structure at the various tiers of government, there is now a ministry of Gender and Social Affairs /regional bureaus/district offices of women’s and children's affairs. At the federal level, one of the duties and responsibilities of the ministry of Gender and Social Affairs is conducting and monitoring gender-related issues and activities at the national level and creating an environment for the implementation of the NPEW in different sectors (even though the policy needs to be updated to match with the current institutional set up). At regional, zonal, Woreda, and Kebele levels, there are respective offices (at the Kebele level, usually individuals are assigned in place of an office). On the other hand, those situated in line sectors/ministries are mandated to identify issues of gender gaps and develop strategies to address inequalities in the respective line ministries and their sub-sectors. The Gender and Social Affairs Offices are formally accountable to their respective councils, many of which have women’s affairs or social affairs committees that are engaged in oversight activities. The plans included steps to enhance rural women’s access to and control over productive resources like land, extension, and credit services.

2.1.9. Violence Against Women

A declaration on the Elimination of Violence against Women Proclaimed by General Assembly resolution 48/104 of 20 December 1993 is talking about recognizing the urgent need for the universal application to women of the rights and principles concerning equality, security, liberty, integrity, and dignity of all human beings. 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 the 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 is aimed at eliminating or, when not possible, mitigating pollution as an undesirable consequence of social and economic development activities. It also states that the protection of the environment and safeguarding of human health, as well as the maintaining of biota and the aesthetic value of nature, are the duty and responsibility of all citizens. It further considers other 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 inter-generational transfer, and limited leasing rights. Provisions are made for the registration and certification of tenure rights. Part Three of the Proclamation presents regulations relating to the use of rural land, particularly as it relates to soil and water conservation and watershed management. The rural land administration and land use laws are to be implemented by the regional states. Landholding right gives the right to use the land for agricultural purposes as well as to lease it and, while the right remains in effect, bequeath it to family members.

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

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

The federal proclamation on expropriation of landholding for a public purpose, payments of compensation, and resettlement (Proclamation No.1161/2019) replaced "Expropriation of Landholdings for Public Purposes and Payment of Compensation, Proclamation No. 455/2005". This new proclamation has been formulated to address, *inter alia*, the fast-growing urban population in major cities of Ethiopia and associated land acquisition for

residential and infrastructure development needs. Rural areas also define the powers and responsibilities of authorities, which oversee property valuation, payment of compensation, and resettlement. This proclamation was made to correct past misgivings due to gaps seen during the implementation of the previous proclamation 455/2005. Considering these gaps, it envisions providing fair compensation and expedites decision-making for those whose land has been expropriated for development purposes. Moreover, it envisions putting in place a grievance redress mechanism to address complaints related to land appropriation and compensation. The proclamation states that the landholder whose land has been expropriated shall be paid compensation for the property on the land and the permanent improvement made on the land. The amount of compensation for the property on the land shall cover the cost of replacing the property anew. The proclamation requires compensation and resettlement for land expropriation to sustainably restore and improve the livelihood of displaced people.

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

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

2.2.6. Labor Proclamation No.1156/2019

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

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

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

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

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

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

This proclamation established a system that fosters coordinated but differentiated responsibilities among environmental protection agencies at federal and regional levels. It clarifies the mandate and responsibilities of the

Federal EPA and the Regional Environmental Authorities (REAs) within the governments of the regional states. The proclamation stipulates that each sector office shall establish an environmental unit to assess and evaluate environmental performance by the sector.

2.2.9. Other strategies and legislations

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

2.2.9.1. 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 Organization in Paris on 17 October 2003. The Ethiopian Government ratified the said Convention on 24 January 2006.

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

This Proclamation shall have the following objectives:

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

2.2.9.3. National Health Policy

Ethiopia has 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 encourage private investment

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

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

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

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

2.3. International Treaties Ratified by Ethiopia

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

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

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

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

2.3.3. International Labor Organization Core Labor 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

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

2.3.5. The Convention on Biological Diversity (CBD)

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

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

This convention was signed by the Heads of State and Governments of independent African States, assembled at Algiers, Algeria on 15th September 1968. Under this convention in Article II, the contracting States shall undertake to adopt the measures necessary to ensure the conservation, utilization, and development of soil, water, flora, and faunal resources per scientific principles and with due regard to the best interests of the people.

2.4. African Development Bank Operational Safeguards

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

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

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

- **OS 1: Environmental and Social Assessment** This overarching safeguard governs the process of determining a project's environmental and social category and the resulting environmental and social assessment requirements. The proposed projects are Category 3 projects as they are less likely to have serious sitespecific environmental and/or social impacts. Likely impacts are very few, site-specific, largely reversible, and readily minimized by applying appropriate management and mitigation measures or incorporating internationally recognized design criteria and standards.

Category 3 investment projects do not require a RAP but may have an ESMP plan to manage and mitigate minor environmental and social risks of projects in compliance with the African Development Bank's safeguards.

- **OS 2: Involuntary Resettlement: Land Acquisition, Population Displacement, and Compensation** This safeguard consolidates the policy commitments and requirements set out in the Bank's policy on involuntary resettlement, and it incorporates refinements designed to improve the operational effectiveness of those requirements. As the risk category of the project falls under category 3 the project does not trigger OS 2 and hence resettlement action plan and livelihood restorations are not needed.
- **OS 3: Biodiversity and Ecosystem Services** The overarching objective of this safeguard is to conserve biological diversity and promote the sustainable use of natural resources. This safeguard could be triggered due to trade-offs of ecosystem services where the availability of solar energy may result in increased withdrawal of water for irrigation (increase production) at the cost of regulatory services such as draining wetlands which are carbon sinks and biodiversity hotspots.
- **OS 4: Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials, and Resource Efficiency** This safeguard covers the range of impacts of pollution, waste, and hazardous materials for which there are agreed on international conventions and comprehensive industry-specific standards that other multilateral development banks follow. The solar mini-grids power plants are meant to curb pollution which is already underway through diesel pumps for irrigation. These operational safeguards are triggered because irrigation activities, especially the use of pesticides, may result in water and air pollution. It is noted that pesticide-related activities are pre-existing within the baseline of farmer activities at these sites. Irrigation activities especially the use of pesticides will result in air pollution.
- **OS 5: Labor 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 labor.

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

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

2.6. Regional Government Offices

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

2.6.1. SNNP Bureau of Agriculture and Natural Resources

The SNNP bureau of agriculture have wide ranges of duties to improve agriculture activities in their respective Regions. The most relevant to the proposed project include the following:

- Provide of agricultural training and extension services. They are responsible for agronomic issues and agriculture conservation practices. Improve agronomic practices in the proposed project area such as crop rotation, intercropping, land preparation, planting method, and planting materials
- Provide agriculture information and extension services to the community and shall be giving similar support to the targeted farmers in the project.
- Support by training the full package and scaling up best practices to all farmers. for such cases, farmers training centers (FTC) is mandated to train farmers on different agricultural technologies.
- Administer the land resource of the region and prepares land use plan.
- Encourage farmers to undertake crop protection to control crop damage or yield reduction caused by insects, diseases, weeds, and other destructive animals
- Follow the implementation of recommended fertilizer rates and time of fertilizer application for the proposed crops of this project

2.6.2. SNNP Bureau of Water, Irrigation and Energy

The Bureau of Water, Irrigation and Energy Development was reorganized as the Bureau of Water, Minerals and Energy Resources Development in accordance with Proclamation No. 178/2011 of the SNNP Regional State Council. The Bureau in SNNP regions has a wide range of duties related to irrigation activities in the regions, the most relevant to the activities proposed include:

- Assigning irrigation experts in the project area to advise and assist irrigation users
- Providing training for irrigation users for the wise use of the water resource
- Forming and following Irrigation Water User Associations to facilitate and manage fair distribution of waters for irrigation

2.6.3. The SNNP Environmental Protection and Forest Authority

The authorities are entitled with the power and wide ranges of duties related to environmental protection. The most relevant to the proposed project include the following:

- Formulate policies strategies and standards pertinent to land and environmental protection
- Administer the land resource of the region and prepare land use plan
- Undertake cadastral survey register land holding and prepare land holding certificate
- In collaboration with concerned organs determine compensation to a person whose land holding has been expropriated for development work
- Regulate and follow up that any development shall conduct ESIA prior to the project implementation
- Undertake environmental auditing of establishments for the safe disposal and management of liquid and toxic wastes

3. Project Descriptions

3.1. Project location

The project area is in SNNP region, Gamo-zone, Arbaminch-Zuria Woreda in Genta Kenchema Ochole Kebele at Murche locality. It is located at 535 km to the South-West of Addis Ababa and at 34 km distance from Arbaminch town, the Zonal capital. It lies in the Main Ethiopian Rift Valley at the foot of western Ethiopian volcanic plateau (Figure 1).

The area is accessible by a road from Addis Ababa to Arbaminch either via Addis Ababa – Butajira – Sodo – Arbaminch or via Addis Ababa – Mojo – Shashemane – Sodo – Arbaminch asphalt roads or by a direct flight from Addis Ababa to Arbaminch among many other routes. Particularly the access from Genta village to Murche site in dry weather is 8km, relatively accessible, except for some periods during the rainy seasons when floods and landslides hamper motor mobility.



FIGURE 1: LOCATION MAP OF PROJECT AREAS

3.2. Project justification and Key information

Mini-grid solar power plants are proved 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 solar-powered irrigation, which would intensify the existing irrigation activities at the project site (see Figure 2 for specifications). Consequently, farmers will have access to reliable electricity which would help them increase agricultural production/productivity, ensure food security and help to mitigate and adapt to climate change.

TABLE 1: PROJECT KEY INFORMATION

Particulars	Description
Project developer/owner	Will be identified later
Type of business	Renewable energy activities
Plant type and capacity	450kW solar PV based AC mini grid
Location	Murche, SNNPR
Manpower requirement implementation phase	7
Project land area	
Area required per kW PV panel installation	
Total area required for PV panel installation	5000 sq. m for Murche

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 and irrigation pumps.

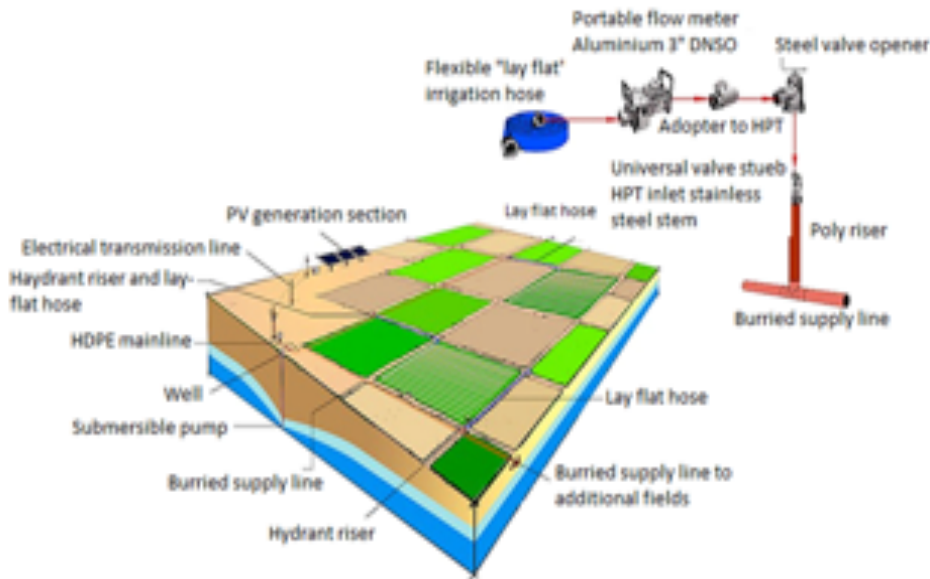


FIGURE 2: IRRIGATION SCHEME DESIGN

3.4. Civil works

Civil works related to the solar PV construction 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 construction of the light buildings (operation and administration building, security posts, storage, etc.).

3.5. Manpower requirement

During the construction phase, installation of solar PV, irrigation pumps and installations of distribution grids are labour intensive and hence the project is expected to hire 100 skilled and 50 non-skilled workers. However, the implementation phase manpower requirement is minimal, it is likely to create jobs for 5 -7 per site and a total of about 14 jobs will be created. Similarly, during decommissioning phase about 6 skilled manpower and over 50 laborers per site are required to dismantle solar panels and other equipment.

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

3.6. Land requirements

The land required for Solar PV modules installations is 0.45 hectares for the Murche site. The total area required, including internal roads, and light buildings, are estimated to be 1 hectare. The area stated was calculated based on an assumption of 12 sqm per kW

3.7. Implementation schedule

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

- Construction starts in May 2023
- Construction lasts for approximately 3 months for the power station

- Operation will resume in November 2023

4. Baseline Information for the Proposed Project Areas

The primary objective of identifying and describing existing environmental conditions is to provide an understanding of the baseline conditions prior to undertaking any development activities. Data were collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. Primary data have been collected to record the micro-environmental features within and adjacent to the project area.

The following section describes the baseline environment into three broad categories:

- **Physical Environment:** factors such as geology, topography, land cover, climate, air quality and hydrology
- **Biological Environment:** factors related to biotic life such as flora, fauna, and ecosystems; and
- **Socio-economic Environment:** population and demographics, land use and sources of livelihoods, social services, and infrastructure.

4.1. Physical and Biological Baseline Information

4.1.1. Geology

Regional Geological Setup

Regionally the project areas fall in the Main Ethiopian Rift (MER). Volcanic activity in the southern MER is divided into three major episodes: Pre-rift volcanic deposits, Syn-rift volcanic deposits and post-rift volcanic deposits. The description for each subunit is given below:

Pre-rift volcanic deposits:

- **Ugayo Rhyolite:** rhyolite with subordinated ignimbrite is exposed in the north-eastern edge of the Arbaminch (e.g., the Ugayo Hill at 1,342m a.s.l.). Rhyolite lava flows and small domes are spatially related to a strongly welded crystal-rich ignimbrite, locally having fluidal texture and rheomorphic deformation.
- **Shole Ignimbrite:** rhyolitic ignimbrite and minor rhyolite are densely welded to non-welded rhyolitic ignimbrite and the pyroclastic fall deposits are exposed on steep slopes of an escarpment. Columnar jointing mainly occurs in moderately to densely welded faces of ignimbrites. Moderately to strongly welded ignimbrite displays a distinct lateral and vertical variation in the degree of welding and clasts abundance. The fine-grained, strongly welded, yellowish to reddish rhyolitic ignimbrite is abundant.
- **Basalt and Dorze ignimbrites:** Geology of the highlands west of the Murche site is dominated by thick basalts. The massive basalt lavas (up to 400m thick) are exposed mainly in the north-eastern part of the Arbaminch around the town of Chench. These basalts are massive, dark-colored rocks with well-developed columnar joints.

Syn-rift volcanic deposits:

- **Mimo trachyte:** forms dykes, as well as small lava flows that are exposed in a road cut between the towns of Arbaminch and Lante. Light-gray trachyte dykes (up to 2 meters in thickness) intruded the pre-rift AmaroGamo basalts. Trachyte is a fine-grained rock with aphanitic to porphyritic texture. Whereas the **Dorze Ignimbrite** represents densely welded rocks cropping out south of the village of Dorze. The predominant yellowish rhyolitic ignimbrite (~30 meters in thickness) reveals various content of clasts and well-developed columnar jointing.

Sedimentary deposits of Upper Pleistocene to Holocene:

- **Colluvial sediments** represent wide-spread gravitationally driven deposits occurring at the foot of escarpments by mass wasting processes (landslides, rock falls, debris flows). These deposits represent heterogeneous material in sediments of different grain sizes.
- **Alluvial sediments** are exclusively preserved on erosion terraces located around the town of Arbaminch or are developed as few meters' thick intercalations within the syn-rift Nech-Sar basalts. **Local Geology**

In the Murche site, the dominant rocks exposed are welded tuff and ignimbrites. Lacustrine sediments were also observed when we traversed along Lake Chamo from the proposed project site.

4.1.2. Soil

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 these again 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. As the project site (Murche) is in the region of main Ethiopian rift valley, the soil is the weathering product of rift valley related pyroclastic flow and alluvial lacustrine deposits. The clay soil in the area contains dark gray to dark-brown soil gradients in color. Based on the previously conducted studies, field observation and landsat TM band satellite images, the type of soils in Murche area is dominated by red brown clay texture soil which is originated mainly from silicic pyroclastic deposits of phreatomagmatic tuff, non-welded ignimbrite, and organic decays. The soil in the area is affected by salinity because it is found in relationship with the volcanically active zone that contains plumes of hot springs. Due to high temperature and associated evaporation and active volcanoes with plumes of hot springs in the rift valley, the salinity content of the soil is high. In general, the soil fertility of the area is low due to salinity, but it can give high yield by treating it with various fertilizers.

Soil samples are taken from this site to characterize the physical and chemical properties at the laboratory. The collected sample is analyzed in Addis Environmental Services for Water & Wastewater Quality Testing Laboratory in Addis Ababa in order to exemplify the macronutrients and macronutrients in the soil of the area and the result is indicated in annex. As shown in the annex, the result of pH, electrical conductivity (EC), macronutrients (Sulfate, Sodium, Sulfur, Potassium, Calcium and Magnesium) and micronutrients (Iron and manganese) are indicated. The pH value of the soil in this site is 7.61 suggesting that the soil in the area is a slightly alkaline soil type that developed mostly in drier areas. 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 low concentration of nutrients. The FAO recommended optimal range of electrical conductivity in the soil is 1100 μ s/cm to 5700 μ s/cm. The electrical conductivity result of the current soil is 219 μ s/cm which suggests the low concentration of nutrients but with slight risk of salinization in the future.

In the same connection, the analytical results of Na, K, Ca and Mg are 140mg/kg (0.6 meq/100g), 70.3mg/kg (0.20 meq/100g), 1220mg/kg (6.1 meq/100g) and 460mg/kg (3.8 meq/100g) respectively. The content of these nutrients in the soil are classified in range by Food and Agriculture Organization (FAO) of the United Nations under bulletin (Roy et al., 2006) for the purpose of interpretation of cation in the soil. FAO cautioned that this classification for each nutrient cannot be considered alone but in relation to the other ions present, and 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). Based on the information in Annex, the concentration of K is low while that of Mg is higher. Whereas the concentration of Na and Ca are medium. Similarly, the concentration of both sulfate and sulfur in the sample are 210mg/kg and 70mg/kg respectively which is below the recommended 500mg/kg-5000mg/kg.

Furthermore, the laboratory results indicated that the concentration of total Fe and Mn are 0.5mg/kg and 0.8mg/kg respectively. 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. The laboratory test result revealed that the concentration of

macronutrients is within the relative range of good fertility, but the concentration of micronutrients in the area shows some degree of deficiency.

TABLE 2: RANGES OF EXCHANGEABLE CATION (CMOL/KG=MEQ/100G) IN SOIL FOR INTERPRETATION OF CATION EXCHANGE DATA (TAKEN FROM FAO BULLETIN, 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

TABLE 3: RANGES OF EXCHANGEABLE CATION (CMOL/KG=MEQ/100G) IN SOIL FOR INTERPRETATION OF CATION EXCHANGE DATA (TAKEN FROM FAO BULLETIN, 2006)

Rating	FAO Classification				Laboratory result			
	Exch. Ca	Exch. Mg	Exch. K	Exch. Na	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	12.14	5.67		1.2
Medium	5-10	1-3	0.3-0.6	0-0.7			0.31	
Low	2-5	0.3-1	0.2-0.3	0-0.3				
Very low	<2	<0.3	<0.1	<0.1				

4.1.3. Topography and Landscapes

The project area lies in the Rift Valley, the adjacent escarpments, and parts of the western Ethiopian and Eastern Ethiopian Plateaus that are dissected by deep river valleys (Kulfo and Hare and Sille Rivers in Gamo highlands).

Murche site falls within Genta Kenchema Ochole kebele representing the lowland of Arbaminch Zuria Woreda of Gamo, Southern Ethiopia. The Woreda surrounding topography is characterized by escarpment and narrow valleys. The slope ranges between 20% and 70%, which has resulted in massive soil erosion. The altitude of the Woreda lies between 1150 and 3300masl. The drainage patterns follow the general topographic orientation so that the small rivers rising from Gamo highlands drain to Lake Abaya and Lake Chamo. Among these, Hare and Baso drain to Lake Abaya, whereas Kulfo, Sille and Segu rivers drain to Lake Chamo.

4.1.4. Climate

The nearest meteorological station for Genta Kenchema Keble is Arbaminch town which is located 15 km eastbound. Based on records of Arbaminch meteorological station Arbaminch has a mean annual temperature of 25°C over the

last 4 decades (Figure 4). On the other hand, rainfall shows a pronouncedly bimodal seasonal distribution (Figure 3). The mean annual rainfall recorded for Arbaminch (1200 m) is about 900 mm while the highland part where most of the streams such as Kulfo and Sille receives much higher rainfall (e.g., Chench a at 2700 m receives 1235 mm (Figure 3)). The main rainy season, which accounts for about 40% of the mean annual rainfall for the proposed project site

at Murche, occurs from April to June, while the lesser rainy season is in September and October. Murche experiences a more pronounced dry season and receives less rainfall because of its low altitude. Its rain-shadow position regarding the moisture-bearing south-east trade winds that prevail in April/May and September/October months in the region. During the months, the proposed project site at Murche experiences water surplus (Figure 3), while the highlands receive excess rainfall, and a surplus is expected for the months from April to October (Figure 3). Thus, most of the water resources, which local people in Murche depend on for irrigation come from the highlands located in the western direction from the site.

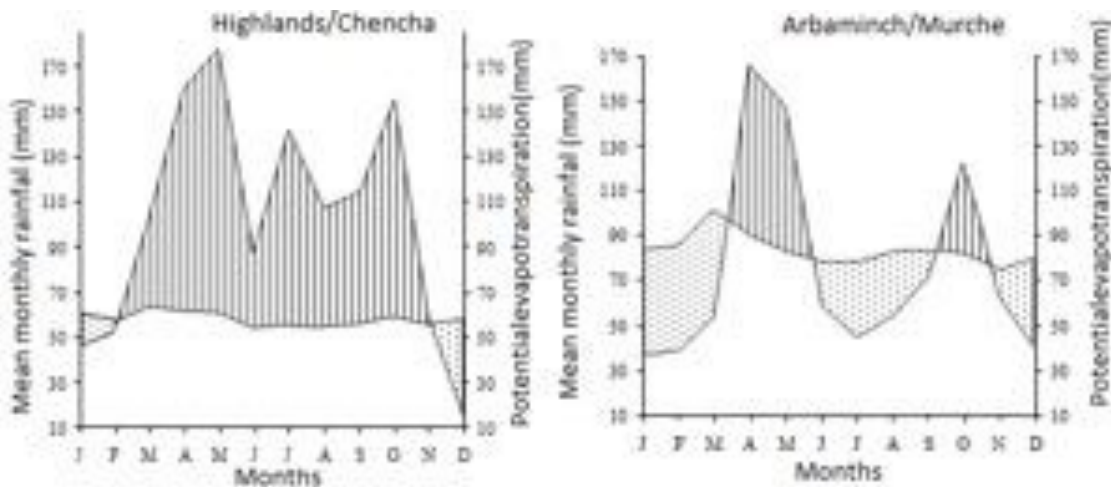


FIGURE 3: CLIMATE DIAGRAM OF THE SURROUNDING HIGHLANDS/CHENCH A (LEFT) AND ARBAMINCH (RIGHT) AFTER THORNTHWAITE (VERTICAL HATCHING INDICATE SURPLUS WHILE DOT PATTERN INDICATE DEFICIT)

4.1.5. Water Resources

Water resources in Arbaminch Zuria area depends mainly on rainfall and other climatic conditions (e.g., potential evapotranspiration, Figure 3) as well as on the hydrological, geological, and topographical settings. Local people at Murche site depend largely on surface water especially Sille stream emanating from the Gughe highlands. Murche's close location to Lake Chamo means there is high potential to extract underground water for irrigation and other domestic uses with some risks of secondary salinization.

Surface water resources in Murche, Arbaminch Zuria Woreda

According to the exploration baseline data by the Ministry of Water, Irrigation and Energy (MoWIE) most of the Kulfo and Sille rivers discharge their water into the Lake Abaya and Chamo which are in the graben of the main Ethiopian rift valley. There are three river gauging stations along the Kulfo Gina sub-basin northeast of Murche following Arbaminch – Chench a road, and another three monitoring stations on Lake Abaya, which were also established by the former Ministry of Water, Irrigation and Energy of the FDRE (recently coined as Ministry of Water and Energy).

According to the same report by MoWIE indicate that the river discharge is directly proportional to the intensity of rainfall within the basin. There is a high discharge fluctuation between the wet and dry seasons of the year. The first high flow period is usually from April to May corresponding to the main rainfall season as shown in Figure 3 above. On the other hand, the months from December to March is largely characterized by low flow when most of the

smaller riverbeds are completely dry. This information is also corroborated by our interview sessions with the local community and stakeholders in Arbaminch. The local communities reiterated that they suffer from water shortage during dry seasons since the volume of Sille river decreases in dry seasons.

Relatively speaking physical water availability in Murch area is better at least for drinking purpose, nonetheless the quality of water for drinking is a concern since some of the shallow wells reportedly have higher salt content (Discussion with community in Murche, 08/10/2021).

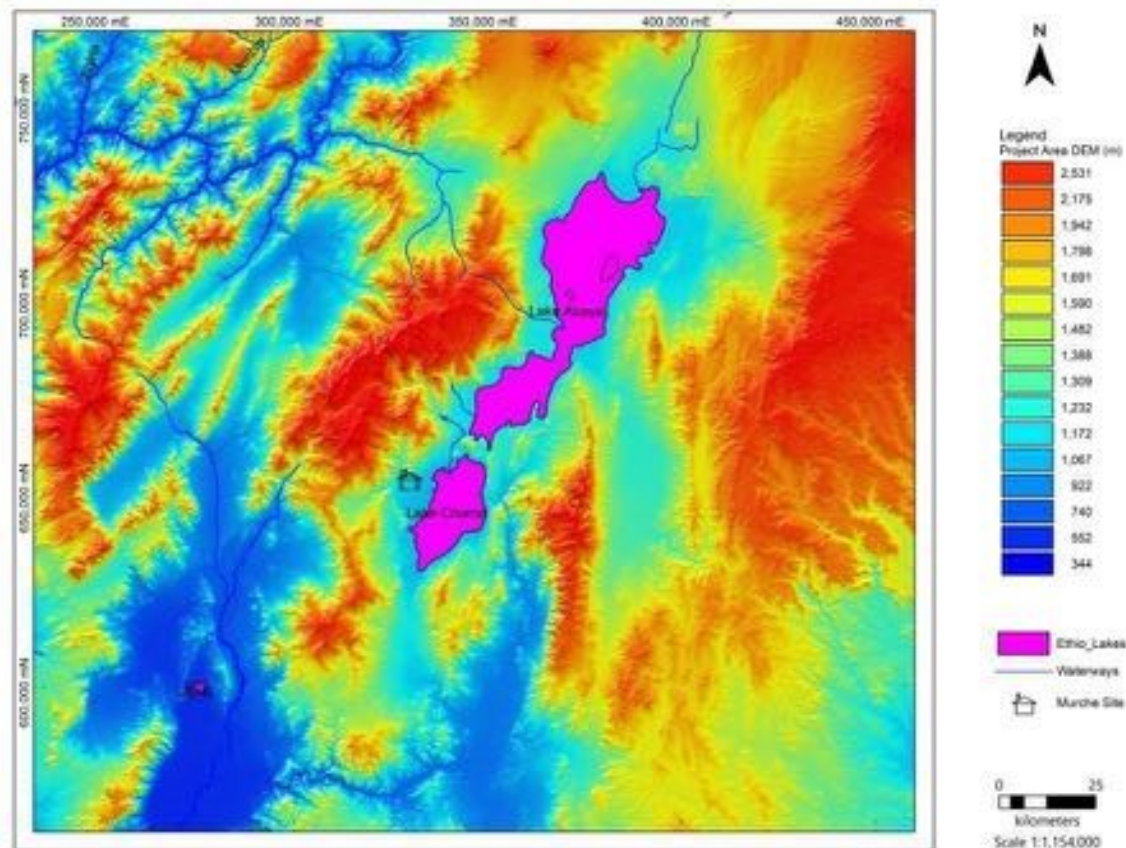


FIGURE 4: LAKE DRAINAGE AND TOPOGRAPHY OF MURCHE AND THE ADJACENT HIGHLANDS

Abaya and Chamo are the two Lakes which were once used to be a single Lake during the pleio-pleistocene period. The two lakes are separated by the “Bridge of GOD”-a ridge separating the two lakes (Figure 4). Lake Abaya looks very much disturbed due to high erosion from the central Ethiopian highlands especially discharges from Bilate River. Due to Climate change, lake levels have changed considerably (3-4 m) (Halcrow 2008). Especially Lake Abaya has shown fluctuations in the last several decades and the level of L. Abaya has continuously increased since 1987 due to climatic variability and land use changes (Shuett et al., 2005, Halcrow 2008). Watershed management should be an integral part of resource management to avoid the situation, which has been happening in Abaya now owing to increased sediment from degraded highlands and nutrient loading due to farming.

A drinking water sample was collected from the deep well, which is currently being used by the community and sent to a laboratory for physic-chemical analysis. The results show that only sodium concentration and turbidity are beyond the WHO maximum limit for drinking water in Murche (**Error! Reference source not found.**).

TABLE 4: SELECTED PARAMETERS OF WATER QUALITY TESTS FOR MURCHE SITE (DETAILS ARE PROVIDED IN ANNEX 1)

No	Parameters	Unit	Murche	WHO maximum limit	Remark
1	Turbidity	NTU	1.85	5	Unacceptable
2	EC	uS/cm	177.6	2000	
3	PH	log10	7.51	6.5- 8.5	
4	TDS	ppm	718	1000	
5	Nitrate, NO3	mg/l	6	10	
6	Total hardness	mg/l CaCo3	200	300	
7	Sodium	mg/l	270	200	Unacceptable

4.1.6. Air and Noise baseline conditions

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 prior to the commencement of any project development and implementation. The ESIA team conducted air quality measurements in the center of the receptor environment where the project is expected to operate. The parameters measured in the field were particulate matter and carbon monoxide. Accordingly, the average air quality measurements for PM2.5 was 0.0055 and 0.0067 for PM10, respectively (Table). Thus, currently both categories of particulate matter are not of concern (PM2.5<0.075 ppm is generally considered as good quality).

TABLE 5: AIR QUALITY MEASUREMENT RESULTS AT MURCHE

	Location UTM	Elevation	CO	PM2.5 ppm			Pm10 ppm			Date & Time
				Min	Max	Av	Min	Max	Av	
				Murche	329709E 652780N	1174 m	0	0.0053	0.0058	

During the construction phase, some noises could be generated from construction machinery (such as excavator, loader, bulldozer, mixers, dump trucks, compactors, generators, etc.) movements. This may disturb workers of the project and the nearby villagers to some extent. Noise by nature is a nuisance and may bring about annoyance, sleep disturbance and interference with communication and cause hearing loss if the level is beyond the acceptable limit (WHO prescribes 55dB for residential areas). However, the construction related 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 (see Table for baseline conditions).

TABLE 6: NOISES MEASUREMENT RESULTS OF MURCHE

Site	Location UTM	Elevation (m)	Noise in dB			Date & Time
			Max	Min	Av	
			Murche	329709E 652780N	1174	

4.1.7. Land Use in Arbaminch Woreda

According to data obtained from the Arbaminch Zuria woreda planning office, the Woreda has a total land area of about 70,765.04 ha of which 72% is already cultivated land under various crop covers including Banana plantations, while forest and bushland constitute about 23% of the land area. There is, however, very little land left for grazing especially along Lake Chamo and Abaya. Areas which are arable but not cultivated constituted only 3% of the total area. 37,684 ha are cropland (cultivated land, 45,916 ha are arable land, 11,897 ha are forest land, 283.96 ha are water bodies, 1064 ha are grazing land, 296.58ha are non-arable land and others 17,946 ha including occupied settlements and roads (Figure 5).

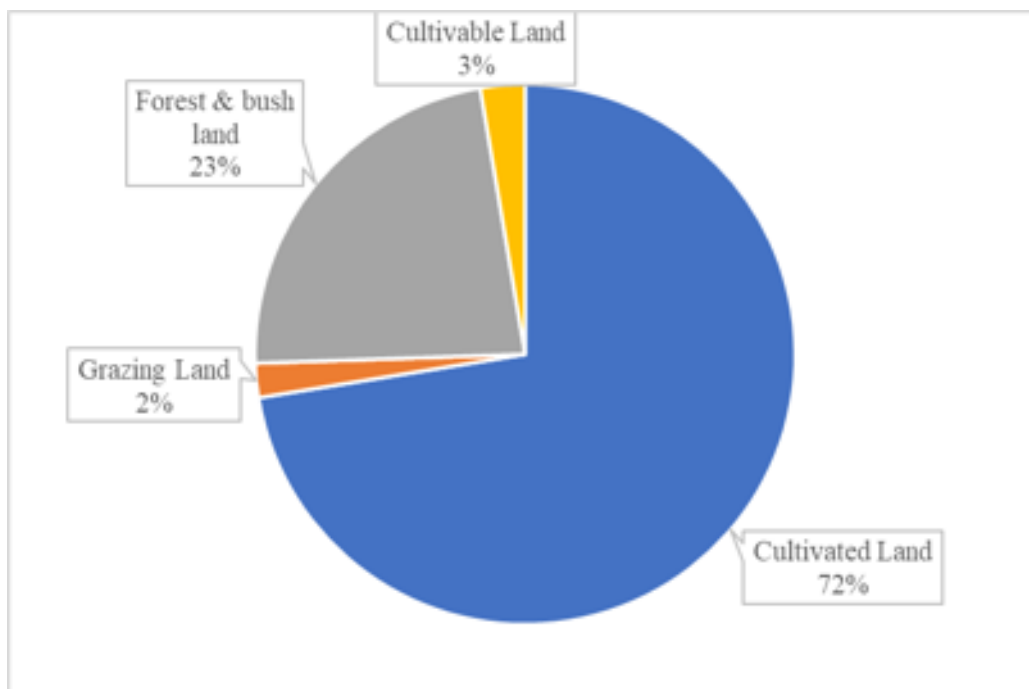


FIGURE 5: LAND USE PATTERN IN ARBAMINCH ZURIA

4.1.8. Flora

The landscape of Arbaminch Zuria woreda, where Murche site is situated, is dominated by farmlands, which are often dotted with some tree species while remnants of forest patches are restricted to locations with difficult terrains such as hillsides and gorges. The major forest trees around the proposed project site include *Cordia Africana* Lam. *Croton machrostachys* Del., *Balanites aegyptica* are some of the trees commonly observed around Murche. The vegetation of the area also includes Eucalyptus species along homesteads and different shrubs and herbs (Table). A variety of fruit trees and shrubs such as *Mangifera indica* L., *Coffea Arabica* L., *Persea Americana* Mill., are being used for agroforestry purposes (Table).

TABLE 7: FLORISTIC COMPOSITION OF THE VEGETATION AROUND NORTHWEST OF THE MURCHE VILLAGE

	Species	Family	Growth form
1.	<i>Sida alba</i>	Malvaceae	Dwarf shrub
2.	<i>Parthenium hysterophorus</i>	Asteraceae	Herb
3.	<i>Jatropha curcus</i>	Euphorbiaceae	Shrub
4.	<i>Manihot esculenta</i>	Euphorbiaceae	Shrub
5.	<i>Solanum indica</i>	Solanaceae	Shrub
6.	<i>Acalypha fruticosa</i>	Euphorbiaceae	shrub
7.	<i>Coffea arabica</i>	Rubiaceae	Shrub

8.	<i>Satureja sp.</i>	Lamiaceae	herb
9.	<i>Croton machrostachys</i>	Euphorbiaceae	Tree
10.	<i>Cordia Africana</i>	Boraginaceae	Tree
11.	<i>Manjefera indica</i>	Anacardiaceae	Tree
12.	<i>Terminalia browni</i>	Combretaceae	Tree
13.	<i>Moringa stenepetala</i>	Moringaceae	Tree

4.1.9. Fauna: Domestic and Wild animals

The livestock population is high in Arbaminch Zuria woreda. According to the 2012 Woreda Animal Health Department report, the livestock population consists of 101,157 cattle; 16,413 sheep; 34,094 goats; 180,266 hen, 967 mules; 615 horses and 4091 donkeys. As it is the case elsewhere in Ethiopia, livestock is an integral part of the farming process. Mules and Donkeys are used as transportation of goods. There are, however, no mules in the Murche village but donkeys are used for the transport of banana and other farm products to the market.

Wild animals: Arbaminch Zuria has two spectacular lakes such as L. Abaya and L. Chamo which hosts diverse types of wild animals. Due to topographic complexity and diverse vegetation in and around the Lakes there are so many animals such as Zebra, Antelopes Grant's Gazelle, Greater Kudu, etc. Especially the southeastern part of Lake Abaya and the northern part of Lake Chamo form part of the Nech Sar national park. In the two lakes and their tributaries, some 16 fish species have been identified, including the Nile perch, Tilapia, and Catfish. Lake Chamo used to have a large fish population. This has now been severely depleted due to over-fishing by cooperatives that fish on Lake Chamo. Along the shores of lakes Abaya and Chamo, wetlands are very common. These wetlands are of outstanding importance as reproduction sites for fishes, crocodiles, and many different aquatic birds and for hippos (Figure 6



FIGURE 6: HIPPOS ON THE SHORE OF L. CHAMO

4.2. Socio-Economic Baseline Information

4.2.1. Administration Structure

Arbaminch Zuria woreda is in Gamo zone, SNNP regional state. Arbaminch Zuria is bounded in the North by Dita and Chencha Woredas, Derashe Special Woreda in the South, Nech Sar National Park in the East, and Bonke Woreda in the West. The Woreda consists of 29 kebeles and its capital town is Secha-Arbaminch, which is located 26 km from Murche village. The total area of the Woreda is 241.62 sq km.

4.2.2. Population and settlement pattern in Arbaminch Zuria Woreda

The total population of Arbaminch Zuria Woreda was 132,360 in 2020, where 65,731 were women and 66,629 were men. Different ethnic groups live in the study area with the Gamo people constituting the indigenous and dominant community. Gamotho is the local language being spoken by 94.49% of the population; Zergulla language and Amharic are spoken by 3.17% and 1.09% of the population, respectively. In terms of religions, many inhabitants follow Protestant and Orthodox Christianity (Arbaminch Zuria Woreda Statistical Report, 2020) while local belief systems are practiced by some people.

In 2020, the adjusted household size of the woreda is 31,295 (in 18 kebeles). The average family size varies significantly from one kebele to another. For instance, the highest average family size was observed in Lante (12.4), Chano (8.5), Shele Mella (7.7) and Chano Chalba (7.00) while the lowest average family size was observed in Zeyse Wozeka (2.00), followed by Dega Ocholo, Zeyse Elgo and Zeyse Dembele (2.9) (Arbaminch Zuria Statistical Report, 2020). The proposed project Kebele (where Murche village is located) has the lowest population density and relatively low family size (Figure 7).

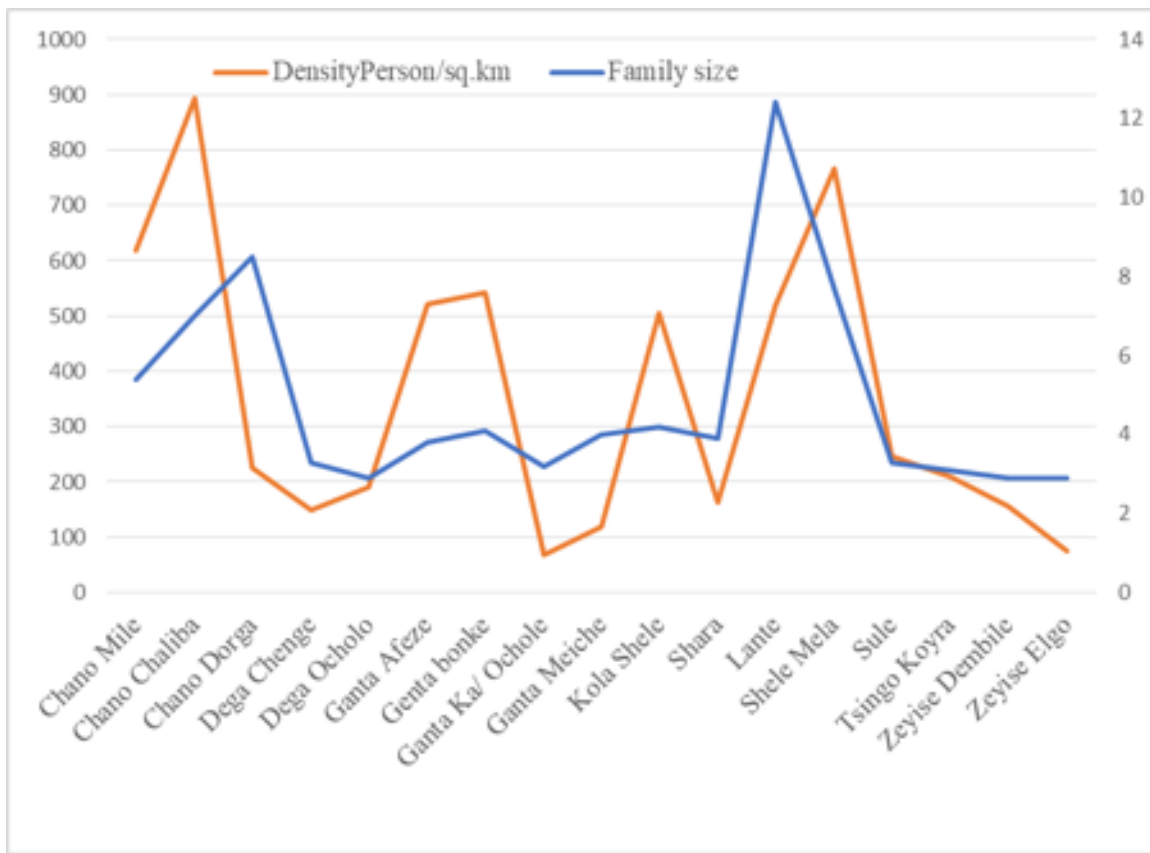


FIGURE 7: POPULATION DENSITY AND FAMILY SIZE IN KEBELES OF ARBAMINCH ZURIA WOREDA

4.2.3. Economic activities and local livelihood in Arbaminch Zuria Woreda

The livelihood of the people in the proposed project area in Arbaminch and its surrounding is predominantly irrigation-based banana plantations and partly maize grown for home consumption. In addition to banana and maize farmers also produce cassava, cotton (Figure 8). The average landholding size of the woreda ranges from 0.5 to 1 hectare per household. As we learned during community consultations, there are a few people who do not have any plot of land and depend on daily labor for their livelihoods. Most of these landless people are migrants from the Gamo highlands who seasonally migrate towards the rift valley (Murche area) and engage in daily labor activities.

Major crops grown on farms are maize, potato, wheat, bean, pea and sorghum while Enset, apple, coffee and sugarcane are grown in the homestead along with various root crops and vegetables, but the area coverage is insignificant compared with fruit crops discussed above.



FIGURE 8: RECENTLY PLANTED BANANA AND MAIZE CROPS AND AN IRRIGATION CANAL DIVERTED FROM SILLE RIVER FOR THE COMMUNITY

As has been said earlier, banana contributes significantly to the local and regional economy because of its high demand in the national capital. During interviews, farmers also informed us that Banana is being exported to towns as far as Bahir Dar and even there were moments when it was exported to the Middle East (see Figure 9).



FIGURE 9: HARVESTED BANANA READY FOR LOADING AT MURCHE VILLAGE (SILLE RIVER ON THE BACKDROP, UPPER LEFT CORNER)

4.2.4. Education Service in Arbaminch Zuria woreda

According to Arbaminch Zuria woreda plan office and annual statistics in 2013 E.C. access to school is still limited to major urban centers. There are several kindergartens in Arbaminch own, elementary schools, secondary schools, and preparatory schools in the woreda. During the public consultation in Murche kebele and discussion with the education bureau of the woreda, they have indicated that schools are not accessible to villages located far away from urban centers and most of the services are concentrated in Arbaminch town. In Murche village, there is only one elementary school. After completing elementary school, children must travel to Arbaminch, which is about 15 km from the Murche village. This is clear by the low general enrolment of students from grade 5 onwards (Figure 10).

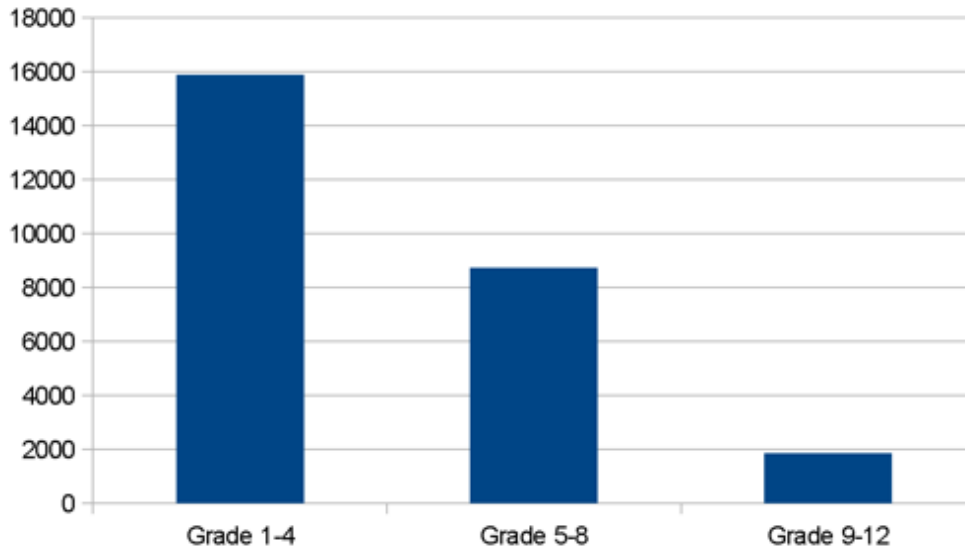


FIGURE 10: GENERAL ENROLMENT OF STUDENTS AT DIFFERENT GRADES IN ARBAMINCH ZURIA

4.2.5. Public Health Facility

According to the Arbaminch Zuria Woreda plan office socio-economic profile (2020), the first ten major diseases in the woreda are malaria, acute febrile illness, typhoid fever, trauma, Pneumonia, gastritis, intestinal disease, skin infection, epidemic typhus, urinary tract infection and diarrhea. There is one hospital, four health centers, and 26 health posts in the Woreda. The modern healthcare system is supplemented by traditional medicinal practices which are prevalent in the area.

4.2.6. Energy Supply

Since Arbaminch Zuria Woreda is located surrounding the Arbaminch town, some kebeles which are at a short distance from the main grid line are electrified. Electricity is not available in the proposed project site at Murche. However, the nearest MV grid line is about 10 km (in Genta Kenchema Kebele center) far from the site. The main sources of energy for the Murche residents are firewood, animal dung, crop residue, charcoal, and kerosene.

4.2.7. Road Infrastructure in Murche Area

Arbaminch Zuria woreda has a total perimeter length of 967.69 km and an enclosed area of 241.62 sq.km. The woreda is interconnected with kebeles with dry weather roads which are often very difficult for farmers to transport their produce to the market and get to services in urban center. Murche site, it takes about 10 km dry weather road from the main Arbaminch-Jinka road. During field work we observed that even this dry road is badly damaged, and it was challenging to drive through the area. The roads are destroyed because of intensive use by ISUZU tracks which were transporting bananas to the market in Addis Ababa.

4.2.8. Historical, cultural, religious, and archaeological resources Physical cultural properties of Murche/Arbaminch Zuria Woreda

During the baseline data collection, the ESIA team visited the Gamo Zone Culture Truism and Sport department. Thus, the following attractions like Maze National Park, Nech-Sar National Park, the Great Rift Valley Lakes (Chamo & Abaya).

The Gamo highlands is well known for its “Enset” (*Enset ventricosum*) production, which is the main source of staple food in the southwest Ethiopia. A tall hut that resembles a giant Elephant head, which is made up of bamboo trees, is an eye-catching residential house in Gamo highlands (Figure 11). Gamo people are also well known for their artistic weaving knowledge, which takes considerable part as an economic base.



FIGURE 11: GAMO CULTURAL HOUSES AND WEAVING BY THE GAMO WOMEN

The other interesting attraction natural and cultural assets are the more than forty natural springs from which the town name Arbaminch (literally translated as forty springs) was derived. The springs are also a significant source of tourist attraction to Arbaminch. There is now a potential threat to this important natural resource due to over consumption due to increasing urban consumption by Aram inch town and the surround local community. Moreover, Crocodile ranch: exclusive crocodile breeding site in east Africa, which is found south of along the western shore of Lake Chamo (Figure 12).



FIGURE 12: CROCODILES IN THE POND OF ARBAMINCH CROC RANCH

4.2.9. Gender Relations

Gender relationship has always been dominated by men; especially productive asset such as land and oxen are owned by men. However, women own animal products such as dairy products. The main source of income for the families is agriculture, mainly irrigation farming and to some extent rearing animals. According to locals, poor people are defined as those who have no fixed assets such as farmlands. According to our discussion with the local people in the proposed project area of Murche, widows or divorced women are more vulnerable to poverty compared to adult men. Poor people in the locality work on in Banana farms. These poor people often get sick because of malnutrition and malaria outbreak.

5. Public Consultations and Stakeholder's Engagements

5.1. Objective of stakeholder consultation

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

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

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

- **Identify:** all those affected by or interested in the project to ensure that they are included in the engagement process.

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

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

5.2. Stakeholders Analysis

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

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

TABLE 8: STAKEHOLDERS IDENTIFIED, THEIR ROLES AND STATUS OF CONSULTATION IN SNNP

Stakeholder	Role and interest/ influence	Status of consultation	Outcome
SNNP region water, mine, and energy office	Regional government	Letter sent, meeting conducted to introduce the project and project team.	Project disclosure was made, data and information were collected
Arbaminch zuria woreda Water, mine, and energy	Local government	Letter sent from the zone and meeting was conducted to introduce the project and project team.	Project disclosure was made, data and information were collected
Community from Murche villages	Host communities, all have an interest in electric power and irrigation, and some have an interest in new job opportunities	Meetings were conducted to disclose the project to communities	PAPs may be identified later when the exact location of the project is known, and the developers are identified
Arbaminch Zuria planning office	Local government	Project disclosure and data request	Socio-economic data obtained

Arbaminch Zuria Woreda Agriculture and Natural Resources Offices	Local government	Letter sent, a meeting was held to introduce project and request data	Project disclosure was made, data on irrigation was obtained
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5.3. Outcomes from Community and major institutional stakeholders' consultations

5.3.1. Murche community

Public consultation was organized in Murche village. The group constituted of elders, farmers, and women. All the group members practice irrigation and rainfed farming. For the discussion and questions, the participants requested to be anonymous so that they would freely express their views. The ESIA team then disclosed the project components and their likely benefits and challenges to the community on October 8, 2021 (Figure 13). The community expressed that they suffer from a lack of electric power for their household, clinics, and other services in the community. Some representatives of the community raised questions on the proposed projects regarding how much the land take will be when the projects materialize. For these questions, the ESIA team responded that land take may not be major, but some plots of land may be affected as the solar power plant would be in the village. Moreover, the team explained that any land being taken away for this purpose will be compensated as per the new proclamation 1161/2019.



FIGURE 13: COMMUNITY CONSULTATION AT MURCHE ELEMENTARY SCHOOL

Date of meeting: 08/10/2021

Venue: Murche Elementary school

Number of participants: Men 12, Women 3

TABLE 9: COMMUNITY CONSULTATION AT MURCHE ELEMENTARY SCHOOL

Name of participant (anonymous)	Issues raised	Responses by the ESIA team
Person 1	We live in “a darkness” for so many years and so long. Can this project provide us with electricity?	The ESIA team explained that providing energy for irrigation and household electricity is the prime purpose of this project. If this solar grid power plant project financed, it will provide electric power for household consumption and irrigation
Person 2	Our crops such as maize and banana are drying out due to lack of diesel and pumps for irrigation water, for at least three months a year. Can this project provide the community with electric pump for sustainable supply of water?	If the project succeeds it would give communities with a reliable energy for irrigation
Person 3	There are no good health facilities in Murche especially women and children suffer from birth complications and malaria infestations. Will this project provide health services to the community?	The ESIA team responded that the purpose of this project is to provide a reliable supply of energy for irrigation and household consumption. However, PV panels can be installed in the existing health center and better health services may be expected.
Person 4	Does the government pay compensation for land taken for Panel construction?	The ESIA team responded that the government pays appropriate compensation for any land intake before the commencement of the project.
Person 5	Does this project intend to dig wells for drinking and irrigation purposes?	Probably yes, but other separate team will answer this question.
Person 6	Who will pay for the compensation of land taken away permanently for solar panel construction?	Compensation is usually paid by the government. There will be a separate committee established for this purposed which will likely involve representatives from the community
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

5.3.2. Institutional stakeholders

The ESIA team arranged a consultation meeting with the relevant offices that may have an influence on the project in SNNP and Sidama regions particularly water, mines and irrigation offices, Sidama culture and tourism office, Gamo zone culture and tourism office. After securing a letter from the regional offices, the ESIA team organized meetings to disclose the project and request them the required socio-economic data. Accordingly, Arbaminch Zuria Woreda relevant offices were identified, and stakeholders’ meetings were conducted. The ESIA team contacted experts from water, mines and energy offices, culture and tourism offices, agriculture, and natural resources offices, and Arbaminch Zuria planning office. With all identified office experts, the ESIA team discussed details about the projects, their scope and target area (Figures 14).



FIGURE 14: SOME THE INSTITUTIONAL STAKEHOLDERS DURING INTERVIEW (HEAD OF GAMO ZONE WATER AND MINES AND ENERGY AND ARBAMINCH ZURIA WOREDA WATER, ENERGY AND MINES)

Invariably, all stakeholders have welcomed the proposed projects and envision that their materialization would be of great value to the local people Arbaminch Zuria woreda. Stakeholders from Arbaminch Zuria Woreda have mentioned that the potential for irrigation is enormous around Arbaminch, and the selected site is one of them. Hence, they have no objections regarding the selected site (Figure 14). The sole limitation is lack of energy where diesel pumps are not only expensive, but fuel shortage presents an enormous problem. However, some of the stakeholders, in both woredas, raised a question that most of the time these kinds of project proposals came by but then had not been materialized. “Would this be like its predecessors?” The ESIA team explained that this is a new business model and hope that it would succeed given the demand is high and it falls squarely with the national development goal. Finally, the Arbaminch zuria woreda agriculture and natural resources office indicated that they have a plan to dig deep wells for irrigation, but capital financing is a problem, could this project be the one to do this kind of service? The ESIA team explained that this is not a finance grant institution so there is no such support but if materialized the project’s objective is aligned to your irrigation scheme.

5.4. Grievances and Redress Mechanism

The mitigation and management plans will be carried out properly. Thus, it is expected that no major grievance issue will arise. However, to ensure that stakeholders have avenues for redressing their grievances related to any aspect that may result from the projects, detailed procedures of redress of grievances should be established. The objective is to respond to the complaints of stakeholders in a timely and transparent manner without resorting to complicated formal channels to the extent possible. The procedure covers stakeholder grievances generated during construction and operation activities. Anyone will be eligible to submit a grievance to the project office, if he/she, believes a practice is having an adverse impact on the community, the environment, or on their quality of life.

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

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

5.4.2. Mode of Grievance

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

5.4.3. Response to Grievances

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

6. Potential Environmental and Social Impact Identification and Significance

6.1. General

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

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

The ESIA team addressed some of the identified impacts based on:

- Identification of the main environmental and social resources and receptors from the baseline data collection from project site
- Literature review of impacts of solar generation project
- Results of the stakeholders and community consultations

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

6.2. Beneficial Impacts

6.2.1. Economic and environmental benefits

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

During the field visit, it was observed that the selected Murche site is favorable to implement modern irrigation activities. However, the farmers are dependent on imported fuel and its cost has been rising over time, in addition they must go long distances to get fuel and its availability has been a challenge for farmers. The planned project, generating energy from solar power, is expected to solve much of the farmers' problems. It will provide and/or increase access to water for many farmers and can have significant effects on agricultural productivity and generated income. There will be a sustainable and diverse food supply throughout the year. Furthermore, the project will increase opportunities to produce market oriented or high value horticulture crops for urban centers.

Employment opportunity

Unemployment is a huge problem in many developing countries including Ethiopia. The development and implementation of this project will undoubtedly be very significant in creating job opportunities for trained, semitrained local youths during the construction and implementation phases. During the public consultation, one of the community's concerns was in hiring technicians for maintenance not to interrupt the middle of cultivation. The project developer will hire trained experts for repairing and maintenance. This proposed project is expected to generate employment opportunities for seven people on a permanent basis during operation and 100 to 120 workers during construction work. This will be a significant impact since unemployment is currently quite high in the woreda and the country at large. Moreover, unemployed youths in the community will form associations and participate in irrigation activities.

Alternative source of energy

Ethiopia has the potential to generate a huge amount of energy from renewable sources like water, geothermal, solar, and wind. The solar energy that is friendly to the environment, clean, and requires limited maintenance is an alternative renewable energy source, especially for countries like Ethiopia having a high amount of annual solar irradiation rate. Besides, for Ethiopia's rural areas where people live in scattered villages, mini-grid solar energy is preferable to develop. Among the various form of renewable energy technologies solar photovoltaic (PV) technology is perhaps the most used one to generate electricity, especially in rural areas all over the world. Currently in Ethiopia some rural areas people use solar energy for household uses. During field visits to project area, it is observed people use solar for charging mobiles and light at home.

6.2.2. Social Benefits Gender equality

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

Knowledge transfer

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

6.3. Potential Adverse Impacts and Mitigation Measures

6.3.1. Adverse impacts during preconstruction phase

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

6.3.2. Adverse impacts during construction

Environmental impacts of the construction phase are expected to be temporary and minimal as all the construction works will be carried out within the site boundary of the project land, for a short period of time and will be controlled via mitigation measures.

6.3.2.1. Generation of solid waste

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

These waste materials create adverse impacts on the biophysical environments of the area if proper avoidance and mitigation measures have not been taken in place and on time. **Mitigation measures**

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

6.3.2.2. Generation of liquid waste

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

Mitigation measures

- Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills
- The wastewater from sanitary and construction works should be collected through the channel in a plastered pond or reservoir and can be recycled for construction, green area, and other purposes after proper filtering and treatment

6.3.2.3. Soil erosion

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

Mitigation measures

- Topsoil shall be set aside and reserved where possible
- Avoid excavation during the rainy season
- Heap the excavated soil in the selected area and reuse it to fill undulating areas
- Drainage measures shall be provided, prior to construction works, to reduce storm water run-off and flash floods

6.3.2.4. Noise pollution

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

Mitigation measures

- Noisy activities shall be scheduled to daytime hours
- Noise disturbance and impact can be reduced by also administration and management decision to work on a shift basis, work rotation and work time reduction for workers in order to reduce their exposure to noise, moving away the workers from the source of noise by restricting area and shutting or turning off noisy equipment or machineries when not needed
- Noise levels at sensitive receptors shall be measured regularly and whenever complaints arise. In instances where workers will be exposed to elevated sound levels, personal protective equipment (PPE) such as ear muffers/plugs should be used

6.3.2.5. Air pollution

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

Mitigation measures

- Workers assigned in the construction machinery operation should wear a dust mask
- The supervisor should strictly follow and make sure this procedure is in place before starting their job
- Water shall be sprayed on all internal roads to minimize dust dispersion when necessary

- Develop a regular inspection and scheduled maintenance program for vehicles, machinery, and equipment to be used throughout the construction phase for early detection of issue to avoid unnecessary pollutant emissions.

6.3.2.6. Impact on public health

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

Mitigation measures

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

- Conduct public health campaigns addressing issues of behavioral change, HIV/AIDS, etc.
- Putting in place appropriate signage to educate workforce and community about the project's HIV policy
- Provision of materials useful for the prevention of HIV/AIDS
- A code of conduct shall be in place to manage worker behavior
- Conducting malaria awareness raising campaign, using mosquito bite prevention methods such as mosquito nets.
- Avoid drinking contaminated water (raising communities' awareness to boil and drink water) to reduce Schistosomiasis infection

6.3.2.7. Impacts on fauna and flora

It may cause temporary disturbance to resident birds with ground nests due to noise, dust, and particulate emissions, and possible illegal hunting by construction workers. Reptiles present within the project site may temporarily move to adjacent locations during construction activities. During the baseline study, it is observed that the project site are selected on bare and sparsely vegetated areas, so there will be minor clearances of some bushes and shrubs.

Mitigation measures

- Restrict activities to allocated construction areas only, including the movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances
- Prohibit hunting at any time and under any condition by construction workers on site

6.3.2.8. Spread of Covid-19

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

Mitigation measures

- Workers shall follow strictly Covid-19 prevention mechanisms
- Temperature measurement checkup each day at the gate of the compound

- Workers should clean their hands with soap and water, or sanitizers or alcohol many times as much as possible each day
- Keep a safe distance (2 meters) from anyone who is coughing or sneezing
- Workers keep proper physical distance from others (2meter) and always wear a mask and avoid handshakes or other physical contact
- Workers do not touch their eyes, nose, or mouth
- Cover their nose and mouth with their bent elbow or a tissue when they cough or sneeze
- Stay home if workers feel unwell
- If workers have a fever, cough and difficulty breathing, seek a doctor on time

6.3.2.9. Traffic accident

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

Mitigation measures

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

6.3.2.10 landscape change and visual impacts

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

Mitigation measures

- Use the excavated soil for backfill during site restoration phase
- Properly store and finally clear construction leftover materials

6.3.2.11. Gender based violence (GBV)

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

Mitigation measures

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

6.3.2.12 Child labor abuse

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

Mitigation measures

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

6.3.3. Adverse impact during Operational phase

6.3.3.1. Impacts on bio- physical environment

6.3.3.1.1. Soil contamination and fertility decline

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

Mitigation measures

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

6.3.3.1.2. Soil erosion

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

Mitigation measures

- Plant trees in areas exposed to flooding
- Provide permanent drainage at the project site to prevent flooding and soil erosion

6.3.3.1.3. Water contamination

The Lake Abaya and Chamo is located to the west of the area surveyed but relates to the Lake Abaya through the Kulfo River. In general, a rehabilitation program is necessary to be implemented to minimize erosion and floods in the catchments. The basements of the lakes Chamo and Abaya require appropriate measures to be taken to protect soil and water.

The impact of water pollution from solar PV plant during operation phase is very minimal. The expected potential source of water pollution is from the permanent workers (e.g., guard, technician) facilities, therefore, sources from these facilities may generate sanitary effluents.

Mitigation measures

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

6.3.3.1.4. Impacts on biodiversity (flora and fauna)

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

Mitigation measures

- Rehabilitation of trees through planting
- Stakeholders should work hand in hand demographic pressure on diminishing natural resources rather than starving to meet its own individual interest with the expense of the park and its objectives.

6.3.3.2. Impacts on socio-economic environment

6.3.3.2.1. Loss of plots of land

Though the implementation of the irrigation project has numerous benefits for most of the local communities, the construction of the solar panel will occupy some amount of land not more than 1 hectare per site. Hence, land take will result in permanent loss of agricultural and grazing lands, though small. However, the area needed for solar is so small and there is chance to construct at communal land. Therefore, it does not result in economic displacement for farmers.

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

Mitigation measures

- Landowners shall be compensated as per the new proclamation No. 1161/2019 before the construction activities started
- Provide job opportunity priority for those, project affected people (PAP) during construction and implementation phases

6.3.3.2.2. Noise pollution

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

6.3.3.2.3. Air pollution

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 atmosphere. In addition to their negative effect in human health, they exert 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 prior to the commencement of any project development and implementation.

As baseline data field measurement was conducted for particulate matter and carbon monoxide in the field. Accordingly, the field air quality measurement for PM_{2.5} is 5.3 µg/m³ and PM₁₀ is 6.5 µg/m³. Though we measured CO at different time the result didn't exceed 0ppm at all measurements.

Upon commissioning, the solar power plant will supply renewable energy using a technology that does not involve the release of greenhouse gases (GHG) during operation. Compared to diesel generators or other thermal power plants, solar PV facilities can thus contribute to reducing air pollution.

Mitigation measures

- Measure levels throughout lifetime of project and address as needed

6.3.3.2.4. Generation of liquid waste

During operation phase, generation of liquid waste from solar mini grid plant is very limited. The major source of liquid waste emanates from sanitary wastewater from restrooms.

Mitigation measures

- Construct a toilet inside the premise and collect sanitary waste and finally dispose it off at permitted area as needed

6.3.3.2.5. Occupational health and safety

The health and safety risks during operation phase will be limited to the solar PV site workers and irrigation user farmers. Technicians who operate or maintain PV panels and transmission lines will likely be exposed to electric shock, burns and body damage as they undertake routine operations and maintenance tasks.

Mitigation measures

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

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

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

Mitigation measures

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

6.3.3.2.7. Fire hazard

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

Mitigation measures

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

6.3.3.2.8. Impacts on tourism and cultural heritage

As described in section earlier, Arbaminch zuria woreda is rich in different culture and tourist attraction areas. However, the information obtained from public consultation, woredas culture and tourism office and field visit conforms the absence of known historical and cultural heritage resources at the project site. However, as always, there is a risk that cultural heritage objects are unexpectedly uncovered during construction activities.

Mitigation measures

- Prepare chance finds procedure based on the World Bank

6.3.3.2.9. Child labour abuse

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

- Provide training for families not to include underage children in their activities

6.3.4. Impact during decommission phase

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

6.3.4.1. Air pollution

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

Mitigation measures

- Workers should wear dust masks
- Spray water on demolishing areas

6.3.4.2. Generation of solid waste

During the decommissioning phase, solid waste will be generated after the use-life of solar modules, batteries, cables, substructures, demolished civil structures, etc. Solar modules can contain potentially hazardous materials, so considerations should be given at the start of the project to determine how units will be disposed of at the end of the project lifetime. **Mitigation measures**

- Hazardous wastes should be dumped in specified protected sites
- Separate recyclable materials and sell for interested buyers

6.3.4.3. Loss of employment

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

Mitigation measures

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

6.3.4.4. Noise pollution

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

Mitigation measures

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

6.3.4.5. Labour influx and GBV

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

6.3.5. Significance of impacts

Identification of impact significance and analysis is a core element in an ESIA process. It involves impact identification, prediction, and evaluation. The most possible potential impacts associated with this project were identified using professional exposure to similar projects, from collected baseline data, community consultation, and professional judgments. Based on these factors, the identified impacts of the project on the biophysical and socioeconomic environment of the area were evaluated and predicted. The identified impacts were evaluated to determine their significance by using typical parameters; type, duration, nature, magnitude, and significance through the project development periods as indicated.

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

TABLE 10: IMPACT SIGNIFICANCE EVALUATION CRITERIA

S. N	Criteria	Impact rating	Description
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1	Extent of the impact	Local	Site specific or confined to project premise
		Regional	Extending beyond the boundaries of the project site and its buffer zone, affecting neighbors, town, local authority, district and even province
		National	Affecting areas beyond the province.
2	Magnitude	Very low	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
		Low	Where the impact affects the environment in such a way that natural, cultural, and social functions and processes continue, albeit in a slightly modified way
		Medium	Where the affected environment is altered, but natural, cultural, and social functions and processes continue, albeit in a modified way.
		High	Where natural, cultural, and social functions or processes are altered to the extent that it will temporarily or permanently cease.
3	Nature	Permanent	When the effect is long-lasting
		Temporary	When the effect is for short period of time

TABLE 11: POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS EVALUATION

S. No	Main Identified Potential Impacts	Type		Reversibility		Impact Extent		Nature		Magnitude	Significance
		Beneficial	Adverse	Reversible	Irreversible	Local	Trans-Region	Temporary	Permanent		
I. Potential positive impacts											
1.	Employment opportunities	x		x		x		x	x	Medium	Medium
2.	Agricultural productivity	x		x		x	x		x	Very High	Very High

3.	Knowledge transfer	x		x		x	x		x	Medium	Medium
4.	Gender Equity	x		x		x		x		Low	Low

II. Potential Adverse Impacts

A. Construction Phase Impacts

1.	Generation of Waste		x	x		x		x		Medium	Medium
2.	Generation of noise		x	x		x		x		low	low
3.	Dust emission		x	x		x		x		low	low
4.	Impact on fauna & flora		x	x		x		x		low	low
5.	Impact on public health		x	x		x		x		Medium	Medium
6.	Workplace Accidents		x	x		x		x		Medium	Medium
7.	Covid 19		x	x		x	X	x		High	High

8.	Soil erosion		x	x		x		x		Medium	Medium
9.	Traffic Accident		x	x		x		x		Medium	Medium
10.	Landscape change and visual impacts		x	x		x		x		Medium	Medium
11.	GBV		x		x	x			x	High	High

12	Child labor abuse		x		x	x			x	High	High
B. Operation Phase Impacts											
1.	Air emission/pollution		x	x		x			x	low	low
2	Noise pollution		x	x		x			x	Very low	Very low
3	Water wastage		x	x		x			x	Medium	medium
4.	Siltation		x	x		x			x	Medium	medium
5.	Water pollution		x	x		x			x	Medium	Medium
6.	Soil contamination		x	x		x			x	Medium	medium
7	Impact on fauna		x	x		x			x	low	low
8	Impact on flora		x	x		x			x	Medium	medium
9	Covid 19		x		x	x	X		x	High	High
10	Sexually transmitted disease		x		x	x	X		x	Medium	Medium
11	Impact on public health		x		x	x			x	Medium	medium
12	Fire Hazards		x		x	x			x	High	High

13	Traffic accident		x		x	x			x	low	low
14	Occupational health and safety		x		x	x			x	Medium	Medium
15	Impacts on culture, tourism		x		x	x			x	low	low
16	Loss of land		x		x	x			x	High	High
17	Child labor abuse		x		x	x			x	High	High
C. Decommissioning phase impact											
1	Pollution		x		x	x			x	low	low
2	Loss of employment		x		x	x			x	low	low

7. Project Alternatives

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

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

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

Project location alternative: The study team have analyzed other site alternatives, based on topography, hydrology, and soil and biological and socioeconomic parameters. Sille River which is a perennial river; currently serving as water source for Murche site. The community practicing irrigation activities in the project area suffer from high price of fuel for their pumps, to alleviate this problem and due to the presence of plenty of water and irrigable lands, made the selected site more favorable.

Project implementation option: the planned project in the selected areas has numerous advantages for the local community. The community can get sustainable energy sources for their irrigation activities, and it enables them to increase agriculture products. Save the community from extra fuel costs and the environment from pollution. The community can also get electricity for their home, school, health post, and their flour mill, getting electricity for these infrastructures will improve the services which provide to the community.

Generally, all the above-mentioned alternatives were analyzed based on technical feasibility, economic viability, and environmental acceptability. Then, the “No Action” alternative has not been accepted while the project implementation option using solar energy is selected because of the numerous project advantages of the project to the local community, and the low negative impacts of the project on the social and biophysical environment.

8. Environmental and Social Management Plan

8.1. General overview

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

- A mitigation plan with mechanisms and actions to minimize negative environmental impacts during construction, operation, and decommissioning

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

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

8.2. Institutional frameworks

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

For the purposes of this project, the SNNP regional bureau of agriculture and natural resources, water and energy will be responsible for enforcing compliance with national standards in the different areas of specialization. At national level Environmental Protection Authority (former EFCC) is responsible for evaluating and approving ESIA study reports as well as for providing environmental approval license which must be obtained prior to the commencement of project implementation.

In addition, environmental protection units from the respective bureaus of agriculture and natural resources are expected to be involved in monitoring of the environmental performance of the solar mini grid power plant project in SNNP region.

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

8.3. Air quality and noise management plan

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

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

8.4. Occupational Health and safety plans

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

For example:

- Providing information materials, instructions, and regular pieces of training for employees regarding workplace injuries and hazards.
- Regular reporting and consultation with employee-elected health and safety representatives and/ or other employees about occupational health, safety, and welfare situations.
- Providing adequate personal protective clothing and equipment to ensure safety
- Ensuring all work procedures are undertaken without exposing workers to hazards

8.5. Waste management plan

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

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

8.6. Community Engagement Plan (CEP)

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

- The Community Engagement Plan (CEP) should be designed on the following principles:
- A Community Liaison Officer for each site needs to be appointed.
- The Community Liaison Officer will initiate the CEP through consultation with key stakeholders identified during community consultation.
- A formal CEP should be produced and documented in consultation with all key stakeholders.

- Through the Community Liaison Officer, the solar PV project proponent will implement a community grievance mechanism allowing community members to raise their concerns about any environmental or social concerns that they may have concerned the project.
- The project proponent will likely take responsibility for the implementation of the ongoing CEP.

8.7. Community Health and Safety Plan

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

- Create awareness between workers and the community to prevent communicable diseases (HIV, Covid19, and other STDs)
- Enforce the drivers to limit speed (not more than 40km/hr.) in the project area and surroundings
- Aware the communities about traffic accidents through campaigns
- Put the traffic and other safety signage in the project site during construction and operation

8.8. Construction phase Environmental Management Plan

TABLE 12: SUMMARY OF CONSTRUCTION PHASE MANAGEMENT PLAN

	Identified Impacts	Mitigation measures	Responsible	Estimated cost
Biophysical Environment	Generation of solid Waste	Hazardous waste, including broken PV panels, shall be disposed of in accordance with best industry practices Any heaps of sand and concrete aggregates in the compound should be cleared to keep the area neat and clean	Minigrad Contractor Woreda agriculture office	Estimated cost for disposal of solid waste 40,000 birr

	Generation of liquid Waste	<p>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</p> <p>The wastewater from sanitary and construction works should be collected through channel in a plastered pond or reservoir and can be recycled for construction, green area and other purposes after proper filtering</p>	Minigrad Contractor	Estimated cost for construction of plastered pond and other storage structure is 60,000
	Soil erosion	<p>Avoid excavation during the rainy season</p> <p>Heap the excavated soil in the selected area and reuse to fill undulating areas</p>	Minigrad Contractor	Labour cost to pile up soil is 30,000
	Noise pollution	<p>Noisy activities shall be scheduled to daytime hours</p> <p>Noise disturbance and impact can be reduced by also administration and management deciding to work on a shift basis, work rotation and work time reduction for workers to reduce workers exposure to noise, etc.</p> <p>Personal protective equipment such as ear muffers/plugs should be used</p>	Minigrad Contractor	For purchasing PPE is 30,000 birr
	Air pollution	<p>Workers assigned in the construction should wear dust mask. The supervisor should strictly follow and make sure this procedure is in place before starting their job; and Water shall be sprayed on all internal roads to minimize dust dispersion when necessary</p>	Minigrad Contractor	PPE included above, and water spray is 20,000 birr
Human Environment	Public health	<p>Conduct public health awareness campaigns addressing issues of behavioural change, HIV/AIDS, etc.</p> <p>Prepare training manual and conduct regular training about STDs</p> <p>Provision of materials useful for the prevention of HIV/AIDS</p>	<p>Community /woreda labour and women affairs office</p> <p>Internal training by Minigrad Developer</p>	<p>Awareness-raising and training 25,000 birr</p> <p>For internal half day training 15,000 birr</p>
	COVID 19	<p>Workers shall follow strictly Covid19 prevention mechanisms such as temperature measurement at the gate of the compound, washing of hands, wearing of masks, avoid handshake, and keep social distance as much as possible.</p>	Minigrad Contractor /EHS unit of the project proponent	PPE cost included above

	Traffic accidents	<p>Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages)</p> <p>Mandatory speed limits not exceeding 40km per hour</p> <p>Collaborating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)</p>	Minigrid Contractor in collaboration with woreda traffic police	<p>Training cost for awareness creation for community and workers</p> <p>20,000 birr</p>
	Gender-based violence/ child labor	<p>Provision of training for workers and families, Community sensitization, regular monitoring for EHS compliance</p>	Woreda labour and women's affairs office	100,000 for training, and regular monitoring
	Impacts on cultural, historical and archaeology-ical sites	<p>If, in case, something new finds is suspected to be religious or historical site during excavations work, Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of construction procedure manual</p>	Minigrid Contractor, supervised by SNNP regional state culture and tourism office	Supervision cost will be 20,000
	Total Minigrid Developer/ Contractor Only			235000
	Total other parties			125000
	Total Construction Phase			360000

8.9. Operational phase Environmental Management Plan

TABLE 13: SUMMARY OF OPERATIONAL PHASE MANAGEMENT PLAN

	Identified Impacts	Mitigation measures	Responsible	Estimated cost

Biophysical Environment	Liquid waste	Construct a toilet inside the premise and collect sanitary waste and finally dispose it off at permitted area	Minigrid Developer	Toilet is expected to be constructed during construction phase
	Loss of farm and grazing land	Landowners shall be compensated as per the new proclamation No. 1161/2019 before the construction activities started Provide job opportunity priority for those projects affected people (PAP) during construction and implementation phases	Minigrid Developer, Woreda Agriculture offices, Woreda administration	The cost will be estimated later by Woreda experts
Human Environment	Occupational health and safety	Use of appropriate PPE during installation and maintenance	Minigrid Developer	Estimated cost to purchase lifetime PPE is 60,000 birr
		The solar mini grid plant should be equipped with a fire-fighting system		
		Ensuring all electrical equipment and machinery are properly grounded		
	Maintenance should be conducted by trained professionals only			
Fire hazards	The solar PV plant should be equipped with a firefighting system	Minigrid Developer	Fire protection systems 40,000	
	The technician should regularly inspect Solar PV components			
Impacts on historical, archeological sites	If, in case, something new finds is suspected to be religious or historical site during excavations work, Chance Find Procedure for physical and cultural resources will be prepared as per World Bank Guidelines - OP 4.11 and will be part of construction procedure manual.	Contractor, supervised by SNNP regional state culture and tourism office	No cost is implied	
Total Minigrid Developer / Contractor Only				100000
Total Operation Phase				100000

8.10. Decommissioning Phase Environmental Management Plan

TABLE 14: SUMMARY OF DECOMMISSION PHASE MANAGEMENT PLAN

	Identified Impacts	Mitigation measures	Responsible	Estimated cost
Biophysical Environment	Generation of solid Waste	Hazardous waste, including broken PV panels, used batteries, shall be disposed of in accordance with best industrial practices	Minigrig Contractor	Waste disposal cost 150,000
	Air pollution	Workers assigned in the demolition should wear dust masks. Spray water on demolishing areas	Minigrig Contractor	PPE for workers and water spray cost 40,000 Birr
Human Environment	Loss of employment	Transfer permanent workers to other active projects Pay compensation (severance) for permanent workers	Minigrig Contractor/regional government	Compensation payment for workers should be paid by the project proponent TBD
	Gender-based violence/child labor	Provision of training for workers and families, Community sensitization, regular monitoring for EHS compliance	Community/Woreda labor and women's affairs office	20,000 for training, and regular monitoring
Total Minigrig Developer/ Contractor only				190000
Total other parties				20000
Total Decommission Phase				21000

9. Environmental and Social Monitoring Plans

Monitoring usually takes two forms, i) compliance monitoring and ii) effect monitoring. The former is about whether impact mitigation and enhancement measures are implemented in time and to the agreed national and international standards. Whereas the latter refers to the monitoring of project-induced impacts on the social and biophysical receptors. Thus, the compliance aspect is monitored by government authorities at the federal level (EPA), and SNNP regional bureau of agriculture and natural resources (environmental protection authority unit) (Figure 15).

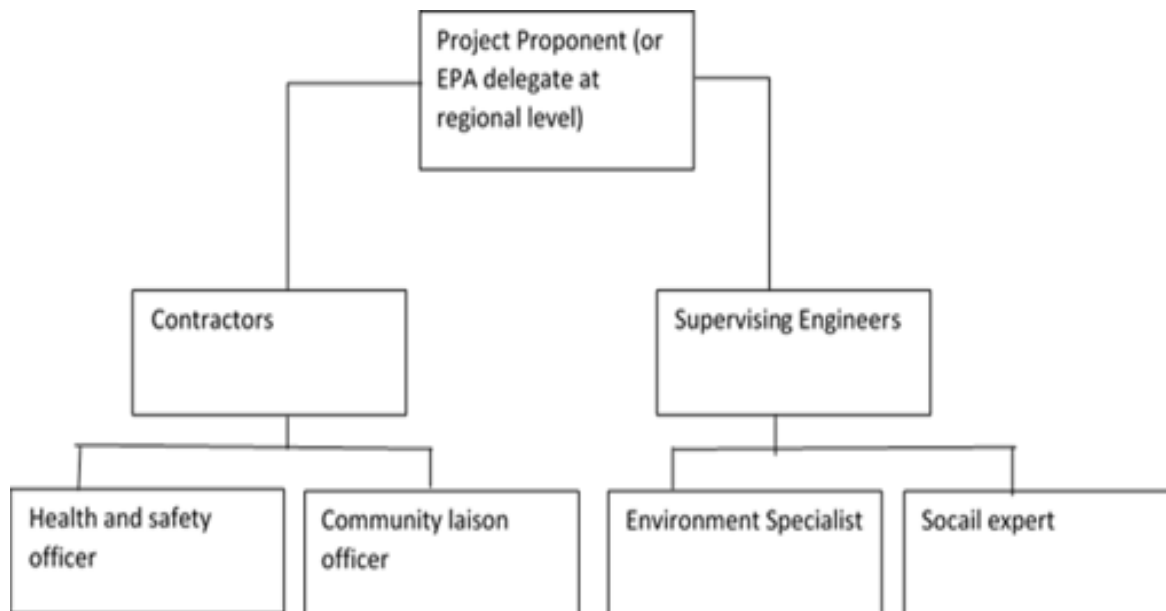


FIGURE 15: DIAGRAM SHOWING ORGANIZATIONAL STRUCTURE OF COMPLIANCE MONITORING

The main objective of the environmental monitoring plan is to ensure that the predicted outcome of the company is achieved. Primarily, its focus will be the sustainable power production of the intended solar mini-grid plant and associated irrigation project and protection of the humans and the environment from adverse detrimental effects. The overall objective of this EMP is to integrate environmental and social considerations into account to ensure successful economic and social development of the project. The regular monitoring program will determine whenever changes or operations are required to reduce the negative impacts and to enhance the beneficial ones. Therefore, conducting monitoring will be of paramount importance.

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

TABLE 15: ENVIRONMENTAL MONITORING PLAN

Parameters to be monitored	Mitigation Measures	Responsible for monitoring	Monitoring schedule	Monitoring indicators	ESM cost in ETH Birr
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Contract management	Make sure the contractor has prepared ESMP for approval for the client	Proponent	Pre-construction and construction phases	Copy of the approved ESMP and implementation of it	Cost internal to developer to get approvals
Social support to vulnerable people	Job opportunities for project-affected people (loss land), Landowners should be compensated as per proclamation No. 1161/2019	Proponent	Throughout operation phase	Interview vulnerable people, and field visit, Check the amount of money paid out from finance	Supervision cost 5,000 birr
Employment opportunity	Hire workers from local people depending on their education, preparedness, and skill level during construction	Proponent & Woreda	Every 6 months	Number of local workers from construction company human resource office	Supervision cost 2,000
Solid waste	Hazardous waste, including broken PV panels, shall be disposed of in accordance with best industry practice Any heaps of sand and concrete aggregates in the compound should be cleared in order to keep the area neat and clean	Proponent	Quarterly during construction and operation	Records of regular waste pickup & disposal	Supervision cost 5,000
Liquid waste	Storage areas for fuel and hazardous materials should be stored in a concrete floor with a bund for secondary containment and collection of spills The waste from sanitary and construction should be collected through channels in a reservoir and can be recycled for reuse during construction, and other purposes after proper filtering	Proponent	Beginning of construction and quarterly each year of Operation	Annual check that the necessary are in place. Constructed plaster pond/ reservoir if required Amount of water recycled	Supervision cost 5,000k to be done in conjunction with above annual visit
Noise pollution	Noisy activities shall be scheduled to daytime hours personal protective equipment such as ear muffers/plugs will be used	Proponent in collaboration with Woreda Health experts	Weekly during the construction phase	Noise level should not exceed the World Bank standard (55dBA and 45 dBA during day and nighttime, respectively)	Expert cost for regular checking of noise level 200,000
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 Water should be sprayed on all internal roads to minimize dust dispersion when necessary	Proponent collaboration with Woreda Health experts	Periodically during the construction and operation phase	Check air quality measurement, air emission shouldn't exceed WHO standards Supervise workers proper use of PPE's Complaints from the local governor, and community	Expert cost for regular check emission level 5,000 to be done together with noise checks

Parameters to be monitored	Mitigation Measures	Responsible for monitoring	Monitoring schedule	Monitoring indicators	ESM cost in ETH Birr
Loss of farm and grazing lands	<p>Landowners should be compensated as per the new proclamation No. 1161/2019 before the construction activities start</p> <p>Provide priority for a job opportunity for those projects affected people (PAP) during construction and implementation phases</p>	Proponent	Before commencement of construction work	<p>Check the amount of money paid for PAP</p> <p>Contractor's personnel office documentation</p>	No cost
Traffic accident	<p>Emphasizing safety aspects among drivers (putting up signposts and other precautionary messages)</p> <p>Mandatory speed limits not exceeding 40km per hour</p> <p>Collaborating with local communities on education about traffic and pedestrian safety (e.g., school education campaigns)</p>	Proponent collaboration with woreda traffic police	Every three months at all phases of the project	<p>Number of accidents on the site</p> <p>Speed limits put at appropriate places</p> <p>Erected traffic sign</p>	Supervision cost 2000, to be done together with above checks
Sexually transmitted diseases like HIV	<p>Health promotion: sensitization of both community and workforce</p> <p>Provision of materials useful for the prevention of HIV/AIDS</p> <p>Having in place appropriate signposts to educate the workforce and community about the Project's HIV policy</p>	Woreda health office	Every month during the construction and operation phase	<p>Number of distributed condoms</p> <p>Check the number of trainings conducted</p>	Training cost 100,000
Covid 19	<p>Train workers to follow strictly Covid-19 prevention mechanisms</p> <p>Temperature measurement checkup each day at the gate of the compound</p> <p>Provision of materials necessary for prevention and detection of COVID 19</p>	Proponent in collaboration with Woreda health experts	Regularly during construction and operation	Number of infected people with covid 19	<p>Expense already included in construction and operations</p> <p>No cost to report # of cases</p>
Occupational Health and safety	<p>Use of appropriate PPE during installation and maintenance</p> <p>The solar mini-grid plant shall be equipped with a fire-fighting system</p> <p>Ensuring all electrical equipment and machinery are properly grounded</p>	Proponent	Regularly during construction and operation	Total recordable incidence rates	for provision of first aid a lump sum of 5,000
Fire hazards	<p>The solar mini-grid plant should be equipped with a fire-fighting system</p> <p>The technician should regularly inspect Solar PV components</p>	Proponent	Every three months during the construction and operation phase	Number of incidents and reported cases	Part of project and operation cost
Impacts on historical, cultural heritage	Excavation work should be done carefully as per World Bank Guidelines - OP 4.11 and prepare chance find procedures	Contractor	During construction work	Number of discovered heritage sites or artifacts	Part of supervision cost

Total Minigrad Developer/ Contractor Only	34000
Total other parties	100000
Total Monitoring	134000

10. Conclusion and Recommendations

Conclusions

The main aim of the environmental and social impact study was to identify, predict and evaluate all the potential environmental and social impacts due to the proposed solar power plant project in Murche (SNNP region). The ESIA study is done with the overall intention of integrating environmental and social concerns into the projects' planning, design, construction, and operation stages.

Environmental and Social impacts have been identified for both components of the project (solar mini-grid) for the proposed project site. For all identified negative impacts, mitigation measures were provided and, in some cases, enhancements for positive impacts were also indicated in chapters (see Chapters 7, 8 and 9).

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

Recommendations

As soon as the project proponent is identified, the project implementation schedule covering all project activities (e.g., solar panel installations, identification of command areas for irrigation, time, and modalities for compensation for land take) should be communicated ahead of time to the Woreda and Kebele administrations as well as to the potentially affected persons. This should be done at least three months prior to the commencement solar mini-grid and irrigation scheme installations.

To avoid any potential conflicts which might delay the project implementation, the potential developer/project proponent should work in tandem with Kebele administrators and local traditional leaders to establish committees in the project area to serve as grievance handling committees, which will serve as avenues for community members to channel grievances to the project proponent. The potential contractor should also prepare the grievance handling mechanism for the workforce during the construction phase, and this must be monitored by the client or any other responsible body.

Monitoring of impacts on the biophysical and social environment should be a continuous process throughout the construction and operation phases in order get lessons for future planning of solar power plant and irrigation projects.

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Annexes

Annex 1: Water baseline data (lab reports for Murche)

ADDIS ENVIRONMENTAL SERVICES
WATER & WASTE WATER QUALITY TESTING LABORATORY

LABORATORY TEST REPORT

Client:	Geoscience Consultants plc.	Lab Ref:	AE/24/01/20
Location:	Region: 506782	Sample No.:	EU/15/1
	Site/Stream: Arka Moch		
Project/Investigation:	ESA Study for Irrigation	Water use:	Irrigation Use
Source of Water:	Surface	Sample Collected on:	04/11/2021
Sample point (ID):	W/1 - 1	Test report issued on:	04/11/2021
Sample Collected by:	Geoscience Consultants plc.	Sample Collected by:	Geoscience Consultants plc.

Test Description: Selected Physicochemical Tests

No.	Parameters	Unit	Value	WHO Maximum Allowable Concentration for Drinking (mg/L)
1	Odourless		Odourless	Indefinite
2	Colour		Colourless	Colourless
3	Turbidity	NTU	0.00	5
4	Total Hardness	mg/L	144	500
5	Ca	mg/L	76	200
6	Mg	mg/L	68	100
7	Total Alkalinity	mg/L CaCO ₃	100	200
8	Ammonium, NH ₄	mg/L	0.46	1.1
9	Bicarbonate, HCO ₃	mg/L	200.5	-
10	Calcium, Ca	mg/L	138	200
11	Chloride, Cl	mg/L	252	250
12	Carbonate	mg/L	92	-
13	Fluoride, F	mg/L	1.10	1.5
14	Magnesium, Mg	mg/L	68	100
15	Manganese, Mn	mg/L	93	0.1
16	Iron, Fe	mg/L	7.75	10
17	Nitrite, NO ₂	mg/L	68	1
18	Phosphate, PO ₄	mg/L	0.79	-
19	Potassium, K	mg/L	1.1	-
20	Sulfate, SO ₄	mg/L	250	250
21	Sulfate, SO ₄	mg/L	68	250
22	Total Hardness	mg/L CaCO ₃	250	500
23	Total iron, Fe	mg/L	0.05	0.3

An Indian Commission research WHO Maximum allowable concentration for drinking water & not recommended for drinking purpose, included appropriate water treatment is recommended in only water suitable.

Test performed by: Yanka Berhane
Checked by: Dagm Gashu
Approved by: Dr. Abba K. Gezahe

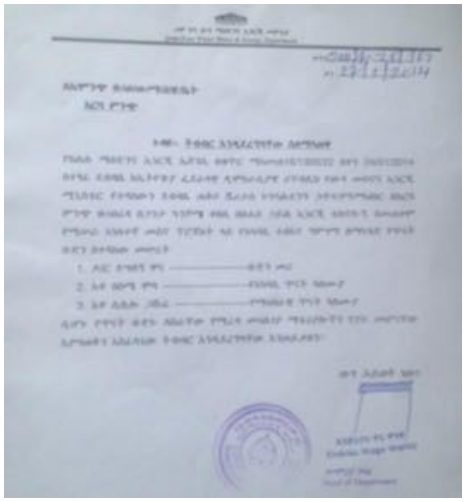
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Annex 2: Consultation minutes

Annex 3: Letters to Regional and local government offices



Annex 4: Soil Sample

ADDIS ENVIRONMENTAL SERVICES
WATER & WASTE WATER QUALITY TESTING LABORATORY

LABORATORY TEST RESULT

Client:	Geoscience Consultancy plc.	Lab Ref:	AES/CAR/22/4
Location:	Region:- SNNPRS.	Sample No:	22/4-2
	Zone/Town:- Gamo.	Wereda:	Arba Minch Zuria.
Project/Institution:	Solar Mini Grid.		For EIA.
Source of Soil:	Surface.	Sample delivered on:	July 14, 2022
Sample point:	Monche(MO-01).	Test report issued on:	July 22, 2022
Sample Collected by:	Geoscience Consultancy plc.	Consultancy:	Geoscience Consultancy plc.

Test Description: Various Physico-chemical Tests

No	Parameters	Unit	Value
1	pH	Log 10	7.61
2	Electrical Conductivity, E.C	µS/cm	219
3	Manganese, Mn	mg/l	0.08
4	Sulfate, SO ₄	mg/l	Nil
5	Total Iron, Fe	mg/l	0.05
6	Sodium ,Na	mg/l	14
7	Sulfur ,S	mg/l	Nil
8	Potassium, K	mg/l	7.3
9	Calcium, Ca	mg/l	122
10	Magnesium, Mg	mg/l	46

Test Performed by: Faska Berhnu
Checked by: Degnet Goshu
Approved by: Dr Addis A. Zeleke

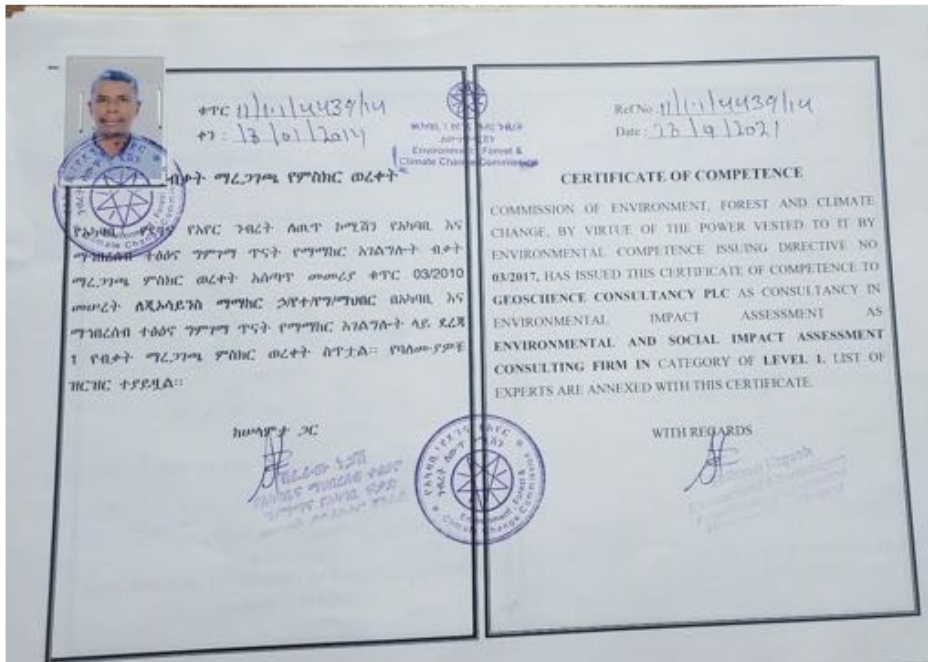
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Signature: *F. Zeleke*

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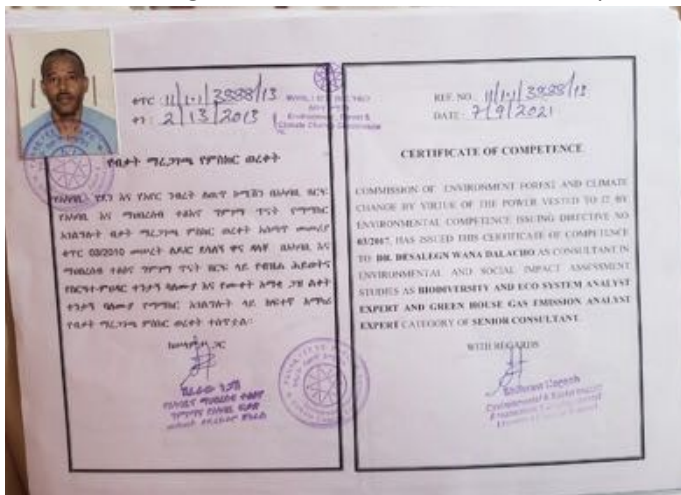
Tel: 0118681459, 0116691773, 0995401532, 0911344928
Email: info@addisenvironmental.com, addisenvironmental@gmail.com
www.addisenvironmental.com

Annex 5: List of ESIA Competence certificates
Goescience PLC competence certificate

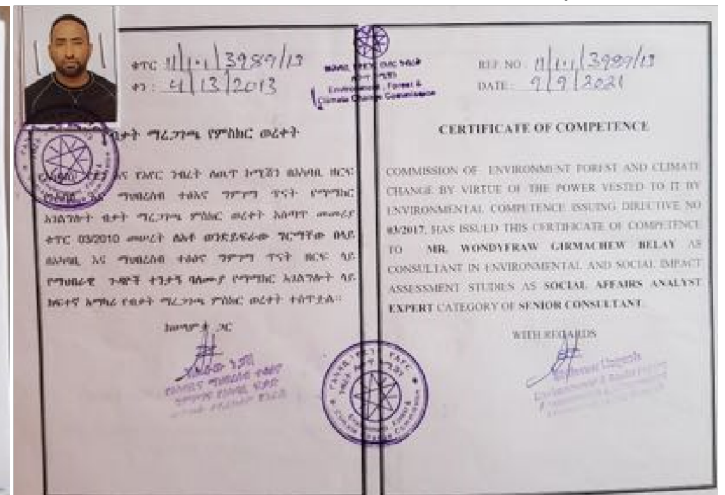


Dr Desalegn Wana, Senior Environmental Expert

Mr. Wondfraw Girmachew, Senior social expert



Demirew Yirgu, Senior Water use expert



MS Hanna Atsbeha, Pollution Expert

