OnePower EIA Scoping

PROJECT BRIEF
NEO I 20MW SOLAR PV PLANT

For submission to Lesotho National Environmental Secretariat

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Acronyms and Abbreviations

CO2	Carbon dioxide
DoE	Department of Environment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EU	Environmental Unit
I&AP	Interested and Affected Parties
ICB	International Competitive Bidding
IECs	Important Environment Components
IPP	Independent Power Producer
LEA	Lesotho Environment Authority
LEC	Lesotho Electricity Corporation
MW	Megawatt
MWh	Megawatt-hour
NAP	National Action Plan
NDP/NSDP	National (Strategic) Development Plan
NEAP	National Environmental Action Plan
NEMP	National Electrification Master Plan
NES	National Environmental Secretariat
NGO	Non-Governmental Organization
PB	Project Brief
PPA	Power Purchase Agreement
PV	Photovoltaic
REU	Rural Electrification Unit
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification

Project Brief:
OnePower Proposal for *NEO I 20MW PV Generation Development Project*

SUMMARY
This document provides information on the Environmental considerations associated with the OnePower Consortium bid for Tender MEM/SOL-001/2016/17 , as required by the 2008 Environmental Act (First Schedule) and following [E A Sec. 28.1]. Information and strategies presented in this document have additionally been compiled with respect to the regulations and recommendations in the 1998 National Environmental Policy and most recent National and District Environmental Action Plans, Development Plans, and Land Use Plans. This document has been prepared by Dr. Amy Mueller, a Director of STG International, who obtained her PhD in Environmental Engineering from the Massachusetts Institute of Technology (2012), and is the newest member of the faculty of Civil and Environmental Engineering at Northeastern University in Boston, Massachusetts. Dr. Mueller has worked and traveled extensively in Lesotho starting from 2005 and has first-hand experience of the environmental issues impacting the highland and lowland ecosystems and the ways these interface with development in the energy sector.

Summary of Key Points:

- The development of the NEO I 20MW PV generating station based on the Government of Lesotho RFP is in alignment with the planning and policy frameworks in place in Lesotho
- The plant facility occupies a footprint of 825m by 416m (343,200 m^2) located 1km northeast of the point of electricity delivery, the 132kV LEC substation in the Ts'ana Talana council of Mafeteng District (Lat -29.807601° Long 27.335344°)
- 70,400 PV panels will be deployed using single axis tracking frames
- Twelve 2MW capacity inverters will be deployed to convert DC to AC
- Step up transformers will increase the AC voltage to inject into LEC's 132kV line
- Approximately 48000 MWh of electricity will be produced per year, avoiding 45500 tons of CO_2
- The site is previously disturbed farmland without residences, waterways, or significance in terms of archeological finds, cultural or historical sites or protected biodiversity.
- The landowner and surrounding community will be fairly compensated for transfer of rights and curtailment of ongoing economic activity at the site
- During construction a temporary worker camp will be established
- Construction employment opportunities (up to 250 jobs) will give preference to the surrounding community
- A backup power system using an LPG generator will provide up to 100kVA power during LEC outages
- Four staff quarters and a control center will be constructed, and 1km of access road
- The plant site will be graded and swales will be constructed to absorb and drain water in a retention pond
- Reforestation of the perimeter of the plant will be used for windbreak and to benefit the community
- Harvested rainwater will be available to the community and used for washing the solar field
- No chemicals or solid or liquid waste will be produced
- **The risk of environmental impact from the operation of the solar power plant is low**
- Based on the above findings, it is recommended that this project proceed to licensing **without** a complete Environmental Impact Assessment study

1. INTRODUCTION AND BACKGROUND

This Project Brief describes the OnePower Consortium proposal for meeting the goals of Tender MEM/SOL-001/2016/17. The purpose of this document is to meet the directives of the 2008 Environmental Act (First Schedule) requiring an analysis of potential impacts of all large scale electrification projects in Lesotho. The proposed project under Tender MEM/SOL-001/2016/17 is the construction of a 20MW Solar

Photovoltaic Power Generation Plant, issued by the Lesotho Government Ministry of Energy and Meteorology, with generated power to be sold to LEC for transmission and distribution through a proximate grid connection (e.g., a sub-station). Contractually the plant must be operated for a minimum of 15 years, however with high quality construction and ongoing maintenance it may be in operation for 25 or more years. This project will both increase the domestically-produced fraction of electricity required to serve Lesotho's population as well as put Lesotho on track to demonstrate to the international community its commitment to the use of renewable resources

This project is aligned with national planning frameworks, legislation, policies, and regulations as outlined in the following section.

2. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

According to the 2008 Environmental Act, all major infrastructure projects are required to take environmental and social impacts of the project into consideration during the planning stage. The first step of this process is development of a Project Brief (*this document*) which is submitted to NES (the environmental authority in Lesotho) and made available for public evaluation and comment. Based on the contents of this document and the public feedback, NES will respond with a determination that (1) adequate evidence is available that the proposed mitigation plans will protect both the ecological and human environment, (2) further study is required, or (3) the project will be rejected on environmental grounds. In any of these cases NES may impose conditions or modifications on the project plan to bring it into compliance with regulations in Lesotho. If the plan is approved, the NES will award an EIA license for implementation of the project as outlined in the agreed upon plan.

2.1 National Environment Secretariat

The National Environment Secretariat (NES) (established in the 1990s) is tasked with the formulation and implementation of environmental policies on a national level in Lesotho. As such, it is NES responsible for evaluation of the Project Brief / Environmental Impact Assessment process as described above. NES also conducts land use planning, regulation enforcement, data collection and analysis for environmental management, environmental awareness outreach, and annual report preparation.

2.2 Environmental Legislation and Policy

Section 36 of Lesotho's Constitution states "Lesotho shall adopt policies designed to protect the natural and cultural environment of Lesotho for the benefit of both present and future generations and shall endeavor to assure citizens a sound and safe environment adequate for their health and well-being." A number of subsequent pieces of legislation have been enacted to uphold this commitment.

National Environmental Action Plan (NEAP): The first NEAP was formulated by the government in 1989 to address environmental degradation. This legislation provides a framework for integrating multiple metrics of concern, primarily taking environmental concerns into account is the creation of social/economic development policies and plans. The NEAP highlights areas of major environmental concern, suggests actions, and defines a structure for national policy.

The Environmental Act of 1999 established the Lesotho Environment Authority (LEA) to provide management of the environment and natural resources in Lesotho. This act was the first to mention the idea of environmental impact assessment. This was followed by the 2008 Environmental Act which updated and codified the environmental protections and the specific requirements of the current EIA process.

National Environmental Policy (NEP): The NEP defines a national program to overcome gaps between individual sector solutions (create inter-sector cooperation) to support sustainable development. The main goals of the NEP are (1) environmental conservation and improvement and (2) contributing to improved quality of life for Basotho through environmental preservation.

The Historical Monuments, Relics, Fauna & Flora Act No. 41 of 1967 protects man-made cultural sites and artifacts as well as 16 groups of fauna and 11 groups of flora. Amendments in 2003 and 2005 added more

protected flora species. Examples of protected species include tortoises, terpins, cranes, storks, herons, egrets, and birds of prey.

The 2006 National Heritage Bill (2006) is "An Act to provide for the protection, preservation and conservation of cultural, natural and living heritage of Lesotho, and for connected matters."

Lesotho has no specific air quality act at the national level, however many local regulations cover release of polluted air streams (fumes, smoke, etc.) with health implications (e.g., the Local Administration Act No. 13 of 1969).

2.3 Treaties and Conventions

Lesotho is party to a number of international conventions with environmental topics, including:

- Vienna Convention for the Protection of the Ozone Layer
- Montreal Protocol on Substances that deplete the Ozone Layer
- United Nations Framework Convention on Climate Change (1992)
- Convention on Biological Diversity (1992)
- United Nations Convention to Combat Desertification

In general these treaties and conventions do not have substantial pertinence to the proposed project. While the project itself may actually in some small way help to reduce desertification, the total land area that will be affected is minimal (less than 1 square kilometer). No ozone-harming chemicals are used in this project. Significantly, if one would suppose that electricity supplied from this project would otherwise have come from coal generation, however, it is certainly the case that this project would be inline with the goals of the UN Convention on Climate Change.

2.4 National Strategic Development Plan

The most recent NSDP was published in 2012 to cover the time period from 2012/13 - 2016/17. The NDP provides a pathway for implementation of the National Vision 2020: "By the year 2020 Lesotho shall be a stable democracy, a united and prosperous nation at peace with itself and its neighbors. It shall have a healthy and well-developed human resource base. Its economy will be strong, its environment well managed and its technology well established." The high-level strategies identified to achieve this vision are:

(I) Pursue high, shared and employment creating economic growth;
(II) Develop key infrastructure;
(III) Enhance the skills base, technology adoption and foundation for innovation;
(IV) Improve health, combat HIV and AIDS and reduce vulnerability;
(V) Reverse environmental degradation and adapt to climate change;
(VI) Promote peace, democratic governance and build effective institutions.

As relates to Energy Infrastructure (under part *II*), the plan specifically identifies the following needs:

- improve safety and reliability of grid connections to households and growth areas
- mobilize investment to take advantage of potential for renewable energy generation in Lesotho, including hydropower, wind, and solar
- promote energy conservation

Furthermore, the design of the proposed project aligns with the following strategic objectives outlined in the NSDP (2012, pg. 102-103):

• Increase clean energy production capacity to attain self-sufficiency, export and have a greener economy
• Evaluate renewable power generation options and negotiate financing arrangements to expand national generation capacity

2.5 Energy Policy and Legislation

The overall policy of the energy sector is to secure energy supply for all sectors and regions of Lesotho at a minimum social, economic and environmental cost. The Lesotho Electricity Supply Act (1969) and the

Electricity Regulations (1970) provide the legal framework outlining the responsibilities of the Lesotho Electricity Corporation (LEC). This includes responsibility for generation, transmission, and distribution of electricity within Lesotho. The 1970 amendments provide specific rules regarding conditions of supply, service requirements, installation requirements, and measurements and payment procedures.

The Lesotho Electricity Authority Act of 2002 established LEA (now LEWA) and contained provisions to:

- Ensure the security of the supply of electricity in Lesotho
- Ensure the promotion of sustainable and fair competition in the electricity sector where it is efficient to do so
- Protect the interests of all classes of consumers of electricity as to the terms and conditions and price of supply
- Ensure, so far as it is practical to do so, the continued availability of electricity for use in public hospitals, and centers for the disabled, aged and sick
- Ensure the availability of health and safety guidance in relation to electricity supply to the public
- Ensure the financial viability of efficient regulated electricity undertakings
- Ensure the collection, publication and dissemination of information relating to standards of performance by licensed operators and on the electricity sector in Lesotho for use by the industry, consumers and prospective investors
- Develop annual supply targets for the purpose of ensuring that such services are accessible to the widest number of electricity users

The Lesotho National Electrification Master Plan (NEMP) study was finalized in 2007, with an objective to provide clear guidelines and establish priorities for providing access to electricity in Lesotho. This report forecast energy demand and established target generation capacity to fufill the objectives of various scenarios for household connection levels through 2020. The NEMP recommended an upgrade to the existing 132kV backbone connecting northern and southern Lesotho from Maputsoe to Mabote; this transmission line is the identified point of delivery of 20MW electricity for the proposed project. The respective roles of the Lesotho Electricity Company (LEC), the GoL Rural Electrification Unit (REU) and the private sector are recommended, including a preferred policy of selecting projects that promote transfer of skills in the case of international competitive bidding (ICB) and advantage partnership with local firms.

The NEMP furthermore considered environmental issues impact and mitigation, recommending:

- Major constructions should be avoided in protected areas and tourism development areas
- Screening for archaeological finds, rock paintings etc. before construction
- Erosion control should be observed when clearing vegetation from construction sites and access roads
- The use of diesel generators should consider the recycling of spent oil

In 2012, Legal Notice No. 38 in the Government Gazette promulgated the Lesotho Electricity Authority Application for Licenses Rules, pursuant to sections 34 and 35 of the Lesotho Electricity Authority Act of 2002. These rules provide guidance for the regulatory process and solicit the following inputs:

1) Statement on ability to finance activities
2) Business proposal with 5 years projected annual cash flows
3) Statement of forecast of first year monthly cash flows
4) Details of expected capital outflows
5) Estimates of net annual cash flows for subsequent periods
6) Expected commencement date
7) Statement on expertise of the applicant
8) Trader's license, Environmental Impact Assessment License, proof of right to use land
9) Power Purchase Agreement signed by the applicant
10) Proposed location(s)
11) Nature and extent of proposed development
12) Name of the Station(s)

13) Number of Generating Units to Be Operated
14) Status of connection to the LEC transmission system
15) Maximum and aggregate power for next 5 years
16) Expected life of generating station
17) Capacity of each generating unit for next 5 years
18) Details of the electricity lines linking the generating station to the network
19) Map identifying the location of the generating station
20) Description of compliance with applicable license conditions
21) Description of proposed location and means by which applicant proposes to supply electricity
22) Plant and lines to be constructed
23) Parts of the system not owned by applicant
24) Status of connection to a transmission system
25) Particulars of person from whom the applicant acquires electricity
26) Expected off take points and quantities
27) Annual Max Demand (MVA) and energy (MWh) to be distributed annual for next 5 years
28) Expected Voltage and Frequency and circuit length per voltage level for the next 5 years
29) Details of estimated connections per voltage level
30) Details of proposed embedded generating station including location and type
31) Details of the net Maximum Power (MVA) expected to be available from the generating station each year for the next 5 years
32) Details of the net aggregate power (MVA) expected to be available from the generating station each year for the next 5 years
33) Detailed map showing the area, including location of in-feeds, overhead lines, cable routes and substations
34) A map showing the actual or proposed configuration of the distribution system including all electric lines and electrical plant affecting connection to the system operated by any other distributor
35) Details indicating that the distribution system will be operated safely
36) Approximate number and expected demand of customers each year for the next 5 years
37) Forecast annual maximum demand (MVA) and energy (MWh) to be sold each year for the next five years

Submission of these details is required for consideration by LEWA in the matter of granting licenses to build and operate generation infrastructure in Lesotho.

In 2015 the Lesotho Energy Policy framework was enacted which envisions the path forward for the energy sector in Lesotho from 2015 to 2025, and included linking the energy sector with other development goals of Lesotho, including contributing towards the improvement of livelihoods, economic growth and investment, security of energy supply, environmental sustainability and gender equality. The policy statements addressed the Institutional and Regulatory Framework for the Energy Sector, including compliance to minimum safety, health, environmental, risks, and service standards in the energy sector. With regard to renewable energy, the 2015 Lesotho Energy Policy sets as objectives to improve the energy security situation by reducing reliance on fossil fuels and imported electricity and to reduce Greenhouse Gas (GHG) emissions from the energy sector. In terms of power generation, the framework envisions that base load requirements should be met through local generation, which maximise the development of indigenous renewable energy resources and enhance the participation of the private sector and cooperative associations in electricity supply. It also calls for development of a power purchase agreement (PPA) framework that will allow the private sector and cooperative associations to participate as Independent Power Producers (IPPs) in mini or micro hydro, wind, solar and biomass power generation. It furthermore establishes institutional roles and pricing processes for energy.

2.6 Land and Road Legislation

The Land Act of 1979 (as amended) defines the process by which land allocation, lease, and title is managed

in Lesotho. In rural areas, this process is overseen by Chiefs and/or Community Councils. This is the primary legal framework used for procurement of land for public purposes (e.g., infrastructure).

The Land Act of 2010 updated these processes, providing current regulations for land vesting, administration, lease, title, and allocation (including definition of the authority for allocation). Part IX outlines the process and restrictions of acquisition of land for public purpose, while Part X covers fair compensation.

The Roads Act No 24 of 1969 covers "locating, constructing, opening, maintaining, protecting, deviating, working and closing of roads." This legislation provides regulations for land adjacent to roads as needed during road construction and maintenance, as well as outlining fair compensation processes for individuals directly affected economically by road construction.

3. PROJECT DESCRIPTION

This section introduces the project objectives, preliminary design, timing and location, regulatory requirements, and employment opportunities.

3.1 Project Objectives and Schedule

The objectives of the OnePower Consortium response to Tender MEM/SOL-001/2016/17 are to provide a 20MW source of renewable energy to the customer base of LEC within Lesotho, while simultaneously improving the physical and economic environments of the surrounding communities. The project schedule has been developed according to the ambitious goals set out in the Tender documents, and we therefore envision the following Project lifetime.

Project Stages

Building and construction	1/2017 – 9/2017
Commencement of operations	*December 2017*
Closure / rehabilitation	*No earlier than 2032; estimated 2042*

Because this infrastructure project is expected to have a long lifetime of useful service, the date of closure is set by the tender as no earlier than 15 years from commencement of operations. Through use of high quality components and a structured maintenance program, however, the power generation station is likely to continue operations for at least an additional 10 years past that target and possibly an additional 10-15 years beyond that.

3.2 Project Components and Initial Design

Preliminary Design

i. *Site* – The facility occupies a footprint of 825m by 416m (34.3 hectares). The design and layout is determined by the geometry and surface area of the ancillary structures and power generation equipment, mainly the dimensions of the PV panels, the tracking frames that support them, the orientation of the single axis trackers to the north, the number of tracking modules per drive system, the length of subsystems whereby PV panels in series reach an open circuit voltage below the 1000V threshold for the inverters, access roads between subsystems, and the relative location of the interconnection point of power delivery. A labelled layout of the site design considering these aspects is shown in Figure 1 below:

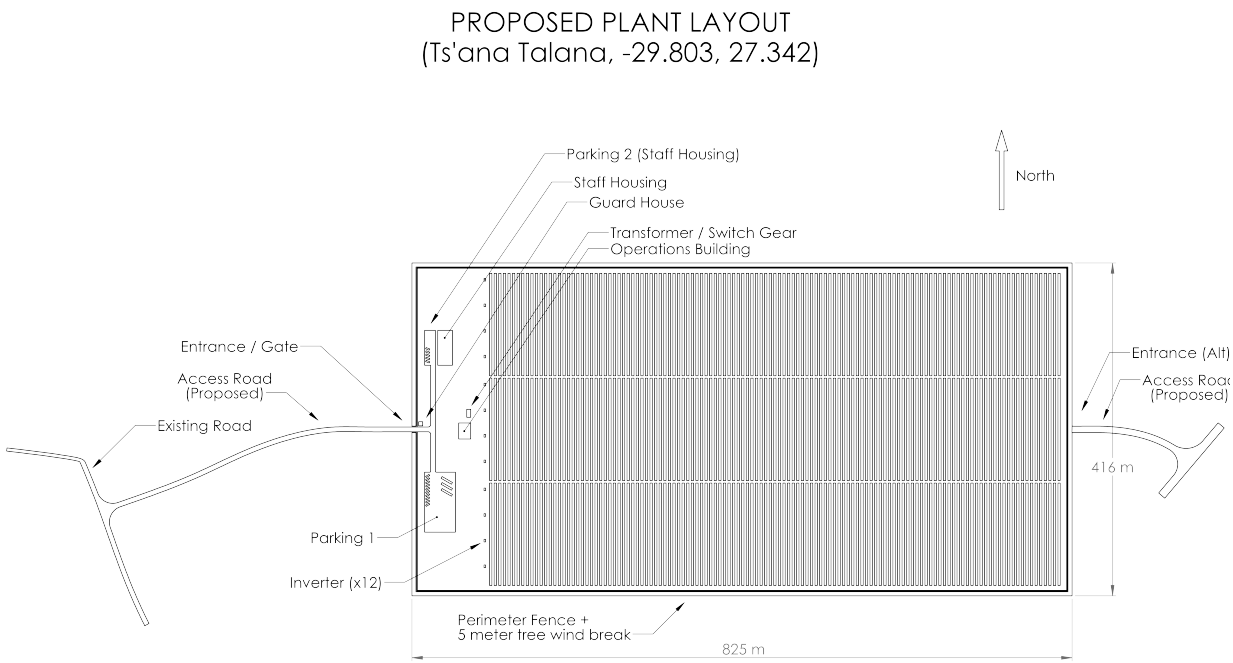


Figure 1: Preliminary layout for the 20 MW Power Plant

ii. *Technology* – The power plant uses crystalline silicon photovoltaic (PV) technology to convert sunlight into DC electricity. 70,400 individual PV panels of nominal 327 Watt peak output will be deployed. Details of the PV panels used are provided in Appendix A. PV panels are mounted in frames that rotate to track the sun from East to West during the day to maximize the sun facing area of the panels. Details of the tracking frames are presented in Appendix B. Inverters convert DC to AC electricity, and combiners, switchgear, and step up transformers are used to inject the power output of the plant into the LEC network. Details of the power electronics and transformer equipment used are provided in Appendix C.

iii. *Construction and operation procedures* – Standard civil and electrical contractor work will be required to build the plant to the Owner's Engineer specifications. International best practices and local codes will be followed. Further details of the specific processes involved are described in the next section.

iv. *Handling of waste* – During the construction phase waste will be collected and transported off site for proper disposal at an appropriate waste management site or recycler. During operation the domestic waste of operating staff will be incinerated, any waste accumulated during repair or maintenance of the facility will be treated as above, and used oil from the backup generator will be stored onsite in a 20L drum that will be transported to a recycler as needed.

<u>Activities and Operations</u>: The project is organized into phases described below.

a) Phase I Construction

i. *Site survey and civil works* - The initial activity will be to demarcate the boundaries of the plant and conduct land surveys to establish elevation gradients and contours. Based on analysis of these data the site will be graded and/or swaled with drainage channels to direct runoff into an offsite dam, and the locations of civil works will be marked for both the ground penetrations to support the PV arrays and the foundations for equipment and buildings. Hydraulically driven precast concrete piles will be emplaced in predrilled pilot holes for anchoring the PV arrays to the subsurface, and concrete slabs will be poured for

the twelve inverters, the step up transformers and switchgear, the power house (offices and control room), the parking lot, the backup LPG generator, the staff quarters, the security guard house, storage building, and LPG fuel tank. Macadam access roads will be graded and improved with compacted crushed stone to provide access to the site to transport personnel, material and equipment and remove waste. The chain link perimeter fence will be installed around the boundaries of the site.

ii. *Work camp* - Crews of technicians and labourers will construct a temporary camp onsite including VIP latrines, trash incinerator, water cistern, tents and prefabricated envelopes for construction offices, mess hall, kitchen, and worker accommodations. These teams will unload materials from flatbed transporters, sort inventory into designated secured storage areas, and operate such equipment and machinery as is needed for moving material within the site and addressing any onsite repairs or modifications to materials and equipment.

iii. *PV solar field installation* - Crews for the solar field will mount tracking frames onto the concrete piles, and completed tracking frames will have PV panels installed with mounting brackets in modules of 6 panels, and subsystems of 8 modules. The single axis tracking system installation will use outdoor rated conduit to connect inclinometer sensors on the tracking frames to control junction boxes that actuate electric motors to turn peripheral drive wheels supported by the tracking frame bases via sprockets and jack shafts. 220Vac power 3-core 4mm^2 cable in outdoor rated conduit will be routed to each of 20 tracking control J-boxes evenly spread throughout the field. Wiring of the PV subsystems with 48 panels in series (850Voc) and 217 subsystem strings be paralleled with cable run to each of the 12 inverters mounted on the concrete pads. The AC output of the Inverters will be wired through to the combiner and switchgear equipment mounted on the concrete pad with the step up transformers.

iv. *Site structures* – The 20MW PV power plant will include construction of a permanent power house with offices and a command and control centre for the operation of the plant. Staff quarters with 4 apartments will be constructed adjacent to the power house, both will include rain water harvesting tanks for domestic water usage and both blocks will be powered by a local 220Vac microgrid supplied by a subsystem of the plant and backed up with a 100kVA LPG fueled generator mounted between the structures and the switchgear pad. A graded Macadam parking lot for project vehicles will be constructed to service the workers and visitors to the site.

v. *Site improvement* – The exterior perimeter (outside of the fence) of the power plant will be reforested with tree seedlings of a variety to be selected in consultation with the local community, in a 5m buffer zone, to avert soil erosion and provide a windbreak for the facility. Available species include *Leucosidea* (indigenous) and Eucalyptus, oak, willow, poplar and similar exotic types. The interior, non Macadam area of the power plant will be landscaped with kikuyu grass (*Pennisetum clandestinum*).

vi. *Commissioning* – The testing and commissioning of the completed plant will be executed in parallel with the decommissioning and removal of the worker camp onsite, with the exception of permanent structures such as VIP latrines, trash incinerator and water cistern.

b) Operations

During the operating phase the solar power plant will generate approximately 48,000 MWh of electricity for delivery at the interconnection point at the LEC substation. A team of approximately 11 technicians, engineers, managers and local site staff will live at or commute to the worksite to maintain the facilities mechanical and electrical systems, conduct routine maintenance and repairs, and ensure that the output of the plant is coordinated with LEC. Periodically, as indicated by visual inspection and metered output, the solar field will be cleaned with water harvested in the dam during rainfall events and filtered though sand before storage in the cistern. Landscaping will be managed by arrangement with local grazing animals from time to time.

Buildings – Passive solar design (sun orientation, thermal mass, overhangs, clerestory windows etc.) will be employed to reduce the energy footprint of the permanent buildings onsite; the buildings will be single story, constructed of locally harvested stone and cement, with galvanized corrugated sheet pitched roofs

and belowground graywater leaching fields.

Water management – An approximately 30m diameter dam will be constructed outside of the facility at the lowest point of the site as a repository of runoff and a drinking source for local livestock. A pump system will elevate the water from the Dam to a sand filter draining into the cistern, which will be used to furnish water for periodically cleaning the panels. Cleaning the entire field will consume 250 cubic meters of water, and cleaning will likely be necessary 2-3 times per year depending on local meteorological conditions and dust accumulation.

Transportation/delivery and storage facilities – in the post construction phase road traffic will be limited to the commuting workers, occasional visits by LEC, LEWA, government personnel or other visitors, and minimal delivery of supplies and materials. Storage of spares will be onsite in a storage facility, and no products or chemicals will be stored onsite except for normal household items as may be found in the staff quarters and the LPG fuel tank and motor oil for the backup generator.

Industrial processes, machinery and methods – The PV power plant operates on a principle of directly converting sunlight to electricity; the entire solar field moves to follow the sun during the day, and low voltage DC output is converted to AC and stepped up to a high voltage of 132kV to be transported offsite to the existing LEC substation less than a kilometre from the solar plant. The 100kVA backup generator operates via a reciprocating piston internal combustion (IC) engine fueled with pressurized liquefied petroleum gas (LPG). This tank must be refilled as needed depending on the usage factor for the generating set. During operation of the LPG genset, CO_2 emissions will result from the combustion of fuel. Operation of the LPG genset is expected to be fewer than 300 hours per annum during operation of the plant.

Daily operation schedule – The PV power plant will operate from 6 a.m. to 6 p.m. or one hour after sunset, whichever is later, on each and every day including weekends and holidays. Other than the LPG genset, there is no noise or pollution from the operation of the plant and as such no disturbance of e.g. religious services can be expected from operations.

3.3 Project Location

The siting of this project was carefully considered to evaluate the following requirements: availability of a rectangular area of roughly 35 hectares, proximity to the LEC 132kV line and substation, limited grade and avoidance of south-sloping, and location in an area of Lesotho with relatively high irradiance (in kWh per m^2 per annum). Due to the mountainous terrain of Lesotho and the prevalence of high irradiance in the western lowlands, the site selection focused on areas adjacent to the existing LEC 132kV line and substation in the Mafeteng district. Four sites near the substation (Lat -29.807601° Long 27.335344°) were initially identified in this area, shown in Figure 2 below.

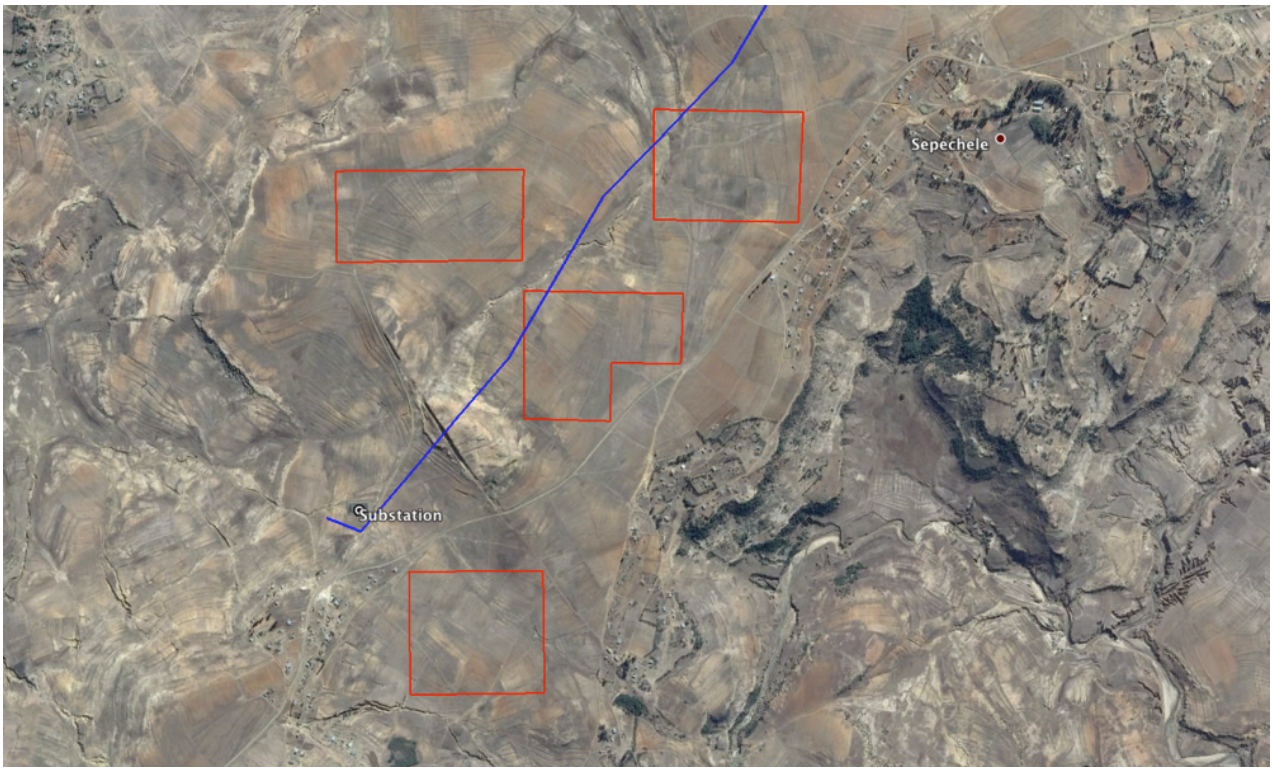


Figure 2: Four initial sites under consideration near the 132kV line (shown in blue) and substation in Ts'ana Talana council of Mafeteng District

Following this initial process using satellite imagery, a series of site visits were conducted to meet with the local chief about prospective sites, assess the elevation gradient, soil stability and erosion, access points, proximity to village areas, schools, clinics and institutions, and documenting the layout of the substation (shown in Figure 3 below). After further considering the length of high voltage wire to connect the PV plant with the substation and the topography of the area, a final site was down selected to meet major requirements in terms of feasibility, performance and cost. A road of approximately 1 km length will be constructed to give site access; permission has already been secured for a right-of-way through adjacent properties. A ground level view of the proposed site is shown in Figure 4, and a projected site layout is indicated on 1:4000 and 1:50000 maps below (Figure 5 and Figure 6).

Figure 3: Lesotho Electricity Corporation substation at 132kV terminus in Mafeteng District

Figure 4: Panoramic view of the proposed 20MW PV generating station site. 132kV towers visible at the horizon.

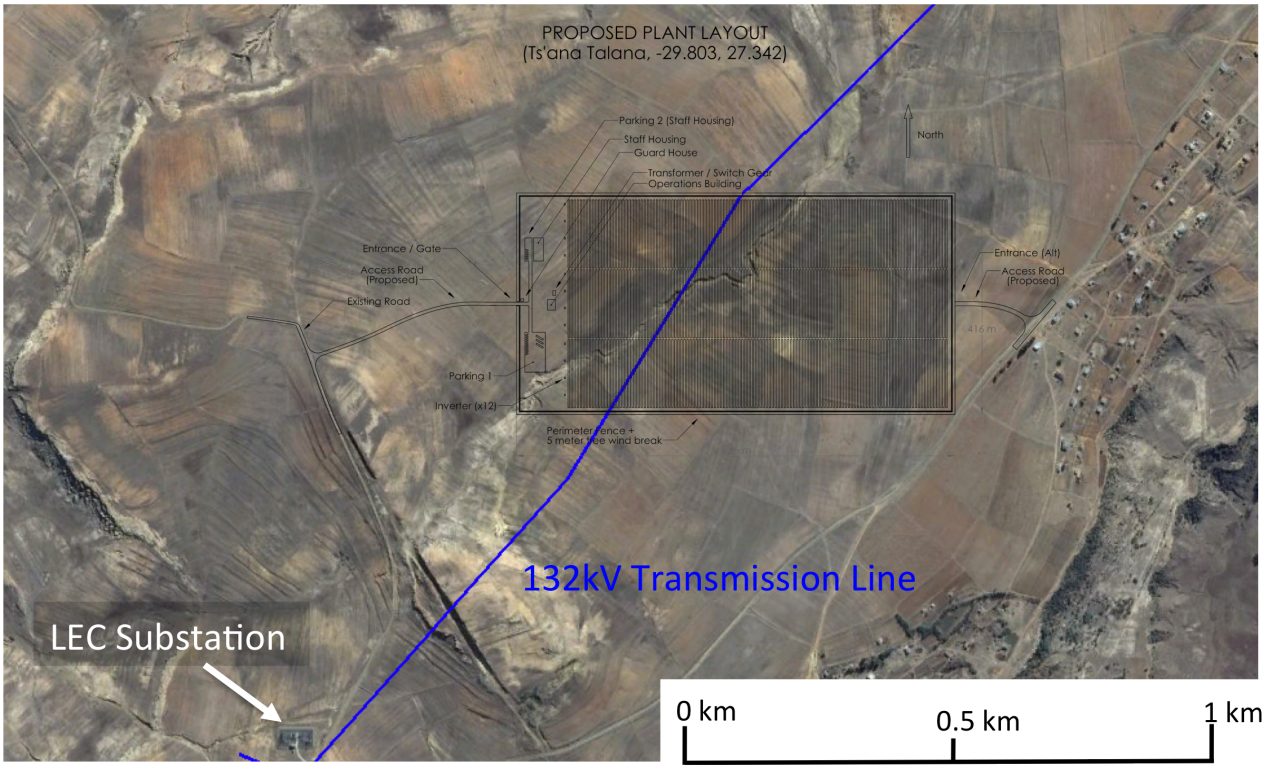


Figure 5: A 1:4000 terrain satellite map of proposed facility location and orientation (sized to page)

Figure 6: 1:50000 map showing overlay of site location and layout (sized to page)

3.4 Planning, Policy, Legal, and Administrative Requirements

As described above, an EIA License is required for all electricity infrastructure projects by the Environmental Act. The project will also require a Building Permit for structures on the site containing electrical equipment, as well as a LEWA License to Generate (see section 2.5 above).

The project does not have substantive pollution pathways and as such will **not** require permits for any of the following: effluent, pollution, noise, ionizing radiation, or waste.

3.5 Employment Opportunities Created by the Project

Employment on site during the 9 month construction phase will employ 250 people in roles ranging from security, groundskeeping, cook, unskilled day laborer, semi-skilled labor, technician, foreman, and engineering and management staff. During the operations phase of the plant 11 people will be employed in technical oversight, safety compliance, maintenance, reporting, site work, cleaning, and security. As much as possible, these jobs will be awarded to qualified individuals from the community near the project site; a non-discrimination policy will be in effect for hiring, specifically aiming to benefit women in the economic development of this region.

4. METHODOLOGY

Assessment of the potential impacts of this project requires consideration of a wide range of topics, including ecological, societal, and economic. The process followed in development of this project brief starts from the main project objective (delivery of 20MW of solar-derived electricity to Lesotho) and then examines how this will interact with both the physical and social environment.

4.1 General

The following sections summarize the efforts to first examine the context of the project (ecologically and culturally) and then second to consider what potential impacts the project may have on these environments. A set of criteria are presented (below) to rank the risk associated with potential impacts, such that all stakeholders have the relevant information required to assess project components. To ensure that all relevant details are collected, we have further identified the stakeholders (I&AP, outlined in the next section) in the project and propose a process for sharing information about the proposed project and soliciting feedback on the design and mitigation plans. In generating these plans, particular attention has been paid to the potential effects of the project on the following environmental components (Table 1):

Table 1: Important Environmental Components

Biological / Physical Components	Human Components
Soil quantity (erosion)	Personal property
Soil quality	Public safety
Habitat	Agriculture
Flora and fauna	(Social) land use patterns
Water quality - groundwater	Health
Water quality - surface water	Cultural values
	Noise
	Aesthetics / Visual

4.2 Interested and Affected Parties (I&AP)

The interested and affected parties for this project include the entire community surrounding the project site, particularly:

- individuals who have historically farmed the land that would be redeveloped
- individuals who may be employed at the project site
- individuals who utilize footpaths through the proposed project site
- individuals who graze cattle and other livestock in the vicinity of the project site

Further, the Local Council as well as locally-operating NGOs are being consulted on how best to identify the community of I&AP.

4.3 Stakeholder Participation

A process has been outlined to solicit stakeholder feedback and participation upon approval of the project from the Tender Committee. Public disclosure of the Project Brief (PB) will be followed by a community meeting for solicitation of response to the contents of the PB. At this stage, the chief of Ha Ramarothole, as well as the community council of Ts'ana Talana, have been consulted about the project and have written letters of willingness to participate / availability of proposed land (Appendix D).

A community meeting (*pitso*) will be organized in the community and in cooperation with the local Chiefs and Council. All community members, as well as LEA and all relevant Environmental Units of the government, will be invited to this meeting. The following regulated processes will be followed:

- LEA will be informed in advance of the list of invited stakeholders, how they have been identified, and invited to add individuals or organizations to the list.
- Invitations will be sent and published publically (see below) at least 30 days prior to the meeting date. Invitations will include details of the place, venue, date, and time of the meeting.
- An independent facilitator will be appointed for the meeting. The facilitator will provide an impartial interface between project staff and stakeholders and enable productive dialog. The facilitator will further be responsible for compiling all questions, requests, and concerns from the meeting and submitting these to LEWA and the project team within 14 working days of the meeting.

Notification of this meeting to the affected communities will be undertaken through several channels identified to ensure awareness of the project and the meeting within the target communities. Adverts will be run in both the Lesotho Times and the Public Eye newspapers with details of the community meeting as well as information about this PB and where it can be accessed. Posters with the same information will be hung in the community to reach individuals who do not typically read newspapers, including at the local schools, shops, and other community buildings. Draft text for the PB announcement is included in Section 9 of this document.

4.4 Criteria and Rating System for Significance of Impacts

The level of significance of potential impacts is rated using three relative categories: Low (L), Moderate (M), and High (H). In cases where some uncertainty exists, impacts may be rated using a range such as L-M or M-H. It is important to note that these risk levels are not referenced to any prior projects in Lesotho where risk may have been borne on a much larger scale, and that all potential impacts identified in the preparation of this Project Brief are minor in comparison to the effects felt by large-scale dam and mining projects. Criteria used for determining the level of significance include impact severity, geographic extent, duration, frequency of occurrence, probability of occurrence, and the possibilities of predicting, avoiding, or reversing the impact.

5. DESCRIPTION of the ENVIRONMENT

5.1 Biophysical Resources

The lowlands range from 1400-1800m elevation and contain a significant portion of the country's population and productive land. Geology of this area is dominated by eroded sandstone, and soils tend to be shallow and highly erodible. The foothills range from 1800-2000m elevation and have similarly high population density. The Senqu Valley region ranges from 1400-1800m elevation and is mainly grassland shallow soils used for livestock and farming. The mountains range from 2000-3400m elevation and are used primarily for summer grazing of livestock, particularly as the soils (basalt) and topography make these areas less suitable for farming.

Rainfall across Lesotho ranges from 400-500mm annually in the southern lowlands and to 700-900mm annually in the northern lowlands. Most mountain areas experience higher rainfall. Global irradiance in Lesotho averages above 6 kWh/m^2 per day.

The relatively undisturbed Highland ecosystems are home 250 species of birds, 50 species of mammals and 30 species of amphibians and reptiles, including several endemic and endangered species of plants, fish and amphibians.

5.2 Environmental Sensitivities

The proposed project site is located in the southern lowland to foothill regions of Lesotho. Because the area proposed for deployment of this project has been utilized for farming by the surrounding community for many decades, it therefore does not currently serve as habitat for any protected species of flora or fauna (no aquatic or terrestrial life). Further, the project site is not in proximity to any protected areas. As is the case across Lesotho, the land is at risk of degradation due to erosion from strong rainstorms, which also results in high suspended particulate (dirt/dust) concentrations in downstream waterways.

5.3 Socioeconomic and Cultural Conditions and Human-Environment interface

The proposed project site is previously disturbed land that is farmed under customary land tenure and is not part of any conservation or biodiversity protection area. The main economic activity in the Ts'ana Talana council is subsistence agriculture and herding. The land designated for the PV power plant is currently an agricultural field that is planted and ploughed annually for staple crops including maize, sorghum, and wheat and potentially potatoes, vegetables, cucurbits, and other marketable or domestic crops. The land is also traversed by livestock herds when it is not in production for crop harvests. Compensation for the transfer of land rights and foregone productivity/economic displacement will be negotiated with the land owner and community interests. No resettlement of households is necessary as there are no homesteads on the plot selected for the power plant site.

Based on preliminary investigations, the selected site is devoid of any specific artefacts of cultural or historical value, including graves, religious sites, historical buildings, cave paintings, dinosaur fossils, or other potentially affected items.

The construction of the plant will create an influx of workers in addition to providing employment options to the local community, and thus require establishment of a worker accommodation camp; this will be built to avoid or minimize adverse impacts on the local community.

6. ENVIRONMENTAL ASSESSMENT

6.1 Project Products and By-Products

The main and sole product of this project is electricity, at a volume of approximately 20MW (will fluctuate as a function of solar input, season, and age of the infrastructure).

Air Pollution: No air pollution is anticipated as a result of this project. Project infrastructure does not include any smokestacks, and vehicle traffic on site will be minimal during operation (limited to maintenance activities). The backup LPG generator will only be used during periods of LEC outage.

Chemicals: No chemicals are used in any process at the project site. The only chemicals stored on site are fuels for (1) the backup generator for maintaining power continuity on site in the event of outages (LPG) and (2) heating buildings on site (LPG).

Wastewater: No process water is utilized in standard operations. Limited volumes of water will be required approximately bi-annually (10L/panel) to remove accumulated dust from panel surfaces; use of a pressure washer enables utilization of unprocessed ground, surface, or collected rain water (no added surfactants), such that water runoff will have essentially natural composition. *Note that this project proposes use of collected rain water to avoid stressing local water supply.*

Noise and Vibrations: There are no significant noise and vibration outputs expected at the plant.

Solid and Liquid Waste: No solid or liquid wastes are generated as a result of standard operations at the plant. In the case of damage to components that require replacement rather than repair, damaged components will be recycled (whenever possible) or disposed of following all relevant laws and regulations.

6.2 Project Benefits and Environmental Enhancement

This project will provide energy security to Lesotho as protection against unstable import of electricity from Eskom; approximately 48,000 MWh of electricity will be produced per year, avoiding the emission of 45,500 tons of CO_2 per year from an equivalently sized coal plant in the Republic of South Africa.

In comparison to its current land use, the proposed site for the 20MW solar generating station will produce benefits beyond the low carbon energy produced onsite and distributed throughout Lesotho. The civil works and swale construction at the site, elimination of tillage and fertilizer application, perennial grass cover, fencing off from overgrazing, and peripheral reforestation, will have the dual effects of 1) limiting runoff from the site (site drainage will contain most surface water at the contours for absorption into the subsurface zone, and direct excess to a dam) and 2) reducing soil and dust erosion and the eutrophication of waterways from fertilizer runoff (and in particular nitrates). The forest windbreak around the perimeter of the site will further reduce runoff, soil and dust erosion as well as provide a resource for sustainable harvesting of biomass and wood, while the dam will be available as a livestock drinking source year round to benefit the local community and provide water resilience during drought conditions.

In addition to environmental benefits, farmers and herders grazing livestock in the project area will be compensated for curtailment of ongoing activity at the site. Employment opportunities will be preferentially available to the local community (with a 20km radius), for cleaning panels, maintaining site function, and security (details discussed below). Skills development will be part of all employment opportunities, throughout the construction and operational phases. OnePower will also represent the case to LEC that proximate communities to this power plant should be prioritized for grid extension projects under the Universal Access Fund.

6.3 Impact Analysis

6.3.1 Anticipated Effects on Natural Environment

Surface and subsurface hydrology, vegetation cover, and albedo will be altered while extensive equipment will be distributed on 35 hectares modifying the landscape. Some of this equipment will utilize small quantities (<1000L) of mineral oils (transformers, backup generator set) or gaseous fuel (LPG) which could leak in the event of an accident – these present a **low** risk of negative impact.

6.3.2 Anticipated Effects on Humans

The siting of the plant will curtail agriculture and farmland will be converted into a solar field. The perimeter fence may close pathways traversing the area, and workers onsite will be subject to safety risks due to high voltages, fuel storage, and moving parts in the tracking modules. The anticipated adverse risk of these impacts is **low**.

6.4 Other Environmental Issues Identified

The potential impacts anticipated above are few and for the most part insignificant from a risk-weighted probability perspective, provided that effective management of the site during all project phases is enforced with respect to standards and best practices and in view of the consultation and involvement of local communities. Short term consequences due to the influx of workers (road traffic, water consumption, litter, noise) during the construction phase can be mitigated by appropriate housing and logistics strategies. Long-term impacts at the site and cumulative effects of the plant over the course of its operating lifetime are unlikely to be negative, and may even be positive (reforestation, improved drainage and water management), given the balance of risks and benefits outlined above.

7. ANALYSIS OF PROJECT ALTERNATIVES

The project outlined in this document is a response to a Government of Lesotho issued request for proposals to build a 20MW solar power plant, and as such analysis of alternatives is confined to alternatives that can maintain compliance with the bidding documents. In particular, alternative locations were evaluated and down selected through a process of project outcome optimization (see Section 3.3). Alternative process configurations are not applicable within the scope of the RFP. Alternative construction methods were considered for the foundations of the solar arrays, including earth screws, poured foundations, precast concrete plinths and ballast, and the use of both fixed tilt and tracking frames for mounting PV panels. Precast concrete driven piles were selected as a preferred approach, however depending on site conditions, alternative foundation methods may be found to be cost effective, pragmatic, and environmentally advantageous. Alternative timelines for the project were not explored as this is stipulated within the RFP.

8. ENVIRONMENTAL MANAGEMENT PLAN

In response to the potential risks identified above, the following section outlines key elements of a plan designed to minimize risk and optimize environmental management and protection. The goal here is to achieve the project objectives with minimal negative impact to the ecological and human environments of the project site, preferably achieving positive impacts for both the ecology and community. The plan first identifies opportunities to avoid impacts that can be avoided. For those impacts that can not be avoided, the plan provides suggestions for minimizing the impacts. The plan also addresses the need for monitoring, including reporting, and recommends environmental training to be conducted.

8.1 Mitigation Measures

A list of proposed mitigation measures responding to risks identified above are included in Table 2.

Table 2: Proposed Mitigation Measures

Potential Impact	Risk Level	Mitigation Measure
Leakage of fuel (LPG) stored on site.	L	Fuel storage on site will be contained in above-ground tanks which are certified pressure vessels inspected regularly to prevent rupture. All hazardous materials / fuel to be contained within a bund with a capacity of 110% of the volume of the largest vessel within the bund.
Decreased air quality from emissions of backup LPG generator in event of extended power LEC outage.	L	Particulates from the exhaust will be mitigated with a soot trap and NOx will be reduced with a catalytic converter.
Runoff and particulates in stormwater	L	One meter elevation swales and a retention pond will be integrated into the site plan. Vegetation removal will be limited to active construction areas only.
Dust and erosion	L	Peripheral tree and intra site grass cover will reduce dust. Access roads will be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement and compaction of soil.
Safety risk of high voltages	L	Perimeter fencing to protect the community and the site; observance of all code based safety standards and best practices
Curtailment of existing land uses	M-H	Fair compensation for loss of farm land and income
Leakage of oil from transformers or backup genset	L	Standard operating procedures and maintenance protocols followed, secondary containment used in storage areas and raised spill bund constructed around the perimeter transformer pads.
Decreased agricultural potential		Minimise degradation of adjacent soils by construction

in adjacent plots		activity - containment of construction activity to smallest possible footprint.
Impact on as yet unidentified heritage site		Although no sites, features, or objects of cultural heritage were identified, it may be possible that sites will be uncovered during excavation activities associated with construction. If at any stage during construction phase any archaeological artefact is observed, it would be vital to stop the work immediately and report this occurrence as per the 2006 National Heritage Bill (2006).

In addition to the Environmental Management Plan, a Resource Efficiency Plan will be developed to identify and implement cost effective measures for minimizing utility consumption and costs in the Facility. It will serve as an effective tool to help understand how the Facility uses energy and water and shall provide ideas for how resources can be used more efficiently.

8.2 Remaining Uncertainty

As with any project of this nature there are potential unknown unknowns. The best way to manage these is through the EMP and having the necessary resources and controls in place to address any eventuality. Residual impacts not considered here may become apparent during civil works and excavations (e.g., graves or archaeological findings) or due to unforeseen circumstances or force majeure. Risk levels may increase if codes and standard operating procedures are not followed, or if political, financial or other considerations force abandonment of the project prior to the implementation of decommissioning, recycling or mitigation efforts. Majority of the aspects and impacts have been identified with mitigation proposed. The residual risk associated with the remaining uncertainty is considered to be low.

8.3 Environmental Training

The OnePower Consortium will have on staff an individual appointed as the Environmental Officer. To ensure an ability to complete this job at a high level of success, this Officer will be enabled to attend available regional short courses in environmental management, environmental assessment, and environmental monitoring. Further an environmental awareness workshop will be conducted with all management and field staff before commencement of site work, guided by input from the Environmental Officer, to ensure that the individuals responsible for addressing environmental issues on a day-to-day basis are aware of the issues, regulations, and mitigation plans. Site and worker health and safety plans will be distributed to all staff members working at the plant and posted in relevant areas (e.g. electrical hazard, high voltage, etc.); materials safety data sheets (MSDS) will be available at any chemical storage point, and waste disposal procedures will be stipulated for specific waste streams.

8.4 Monitoring and Reporting

The project will be monitored on a regular basis, established in the OnePower operations protocols, to ensure that the management plan is implemented effectively. The Environmental Officer will be responsible for monitoring the construction activities and maintaining monthly reports on performance against the EMP in a systematic manner. Monitoring technique and procedures will be taught through a short environmental monitoring course.

For monitoring to be effective, monitoring findings must be reported to management. There must be a system in place to ensure that these findings are provided with timely and effective responses by management. A detailed monitoring plan and procedure will be developed during the monitoring training course. Should external reporting be required this will be the responsibility of the Environmental Officer.

9. RECOMMENDATIONS AND NOTICE

9.1 Recommendation

This Project Brief identifies the ecological and societal context of the project, including rating risk factors in both categories. In total only very few potentially negative affects have been identified, all at Low risk levels except for the explicit land use change proposed (conversion of farm land). Because this has been identified as the critical potential effect, discussion and negotiation has already commenced with the individuals charged with management of this land (Chief, Council) who are supportive of this proposal for its potential to create local jobs. A critical next step in this process is the solicitation of feedback on the Project Brief from stakeholders, particularly through a public meeting with the I&AP, to identify any additional areas of concern or risk. If no High or Medium-High risks are identified through this process, this project should be able to proceed to the implementation stage with little to no negative impact on the local environment; therefore a full formal Environmental Impact Study is not recommended at this time.

9.2 Draft Notice

For attention to the communities of Ts'ana Talana council and surrounding: The OnePower Consortium is soliciting public comment and feedback on plans for a proposed 20MW solar photovoltaic power plant to be installed near Ha Ramarothole, Mafeting District in response to Tender MEM/SOL-001/2016/17. A preliminary Project Brief has been completed and is available for review at ATS/Rural Main North 1 (Khubetsoana) for the next 30 days. Following this review period a community meeting will be held at Mafeting on July 1 to enable direct inquiry of the project team and collect comments for presentation to LEC through an official independent summary report.

10. REFERENCES

Government of Lesotho. 1970. Electricity Regulations 1970. Legal Notice No. 16
Government of Lesotho. 1989. National Environmental Action Plan.
Government of Lesotho. 1997. Environmental Bill1997.
National Environment Secretariat. 1998. National Environmental Policy for Lesotho.
Government of Lesotho. 2002 Lesotho Electricity Authority Act
Government of Lesotho. 2007. National Rural Electrification Master Plan.
Government of Lesotho. 2012. National Strategic Development Plan 2012/13 – 2016/17.
Government of Lesotho. 2015. Lesotho Energy Policy Framework.

APPENDIX A – PV PANELS

SunPower® E-Series Commercial Solar Panels | E20-327-COM

More than 20% Efficiency

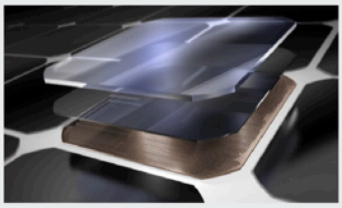
Captures more sunlight and generates more power than Conventional Panels.

High Performance

Delivers excellent performance in real world conditions, such as high temperatures, clouds and low light.[1,2,4]

Commercial Grade

Optimized to maximize returns and energy production, the E-Series panel is a bankable solution for commercial solar applications.



Maxeon® Solar Cells: Fundamentally better.
Engineered for performance, designed for reliability.

Engineered for Peace of Mind

Designed to deliver consistent, trouble-free energy over a very long lifetime.[3,4]

Designed for Reliability

The SunPower Maxeon Solar Cell is the only cell built on a solid copper foundation. Virtually impervious to the corrosion and cracking that degrade Conventional Panels.[3]

#1 Rank in Fraunhofer durability test.[9]
100% power maintained in Atlas 25+ comprehensive Durability test.[10]

High Performance & Excellent Reliability

SPR-E20-327-COM

E20 SERIES

High Efficiency[5]

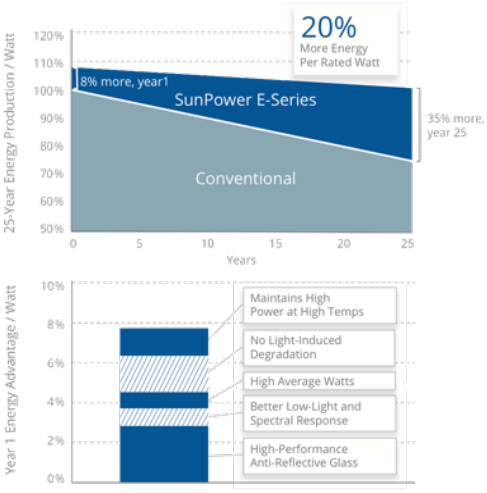
Generate more energy per square foot

E-Series commercial panels convert more sunlight to electricity producing 31% more power per panel,[1] and 60% more energy per square foot over 25 years.[1,2,3]

High Energy Production[6]

Produce more energy per rated watt

More energy to power your operations. High year one performance delivers 7-9% more energy per rated watt.[2] This advantage increases over time, producing 20% more energy over the first 25 years to meet your needs.[3]



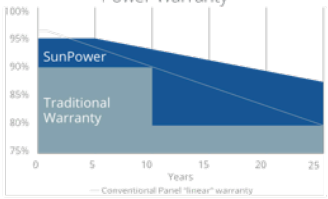
Data Sheet

SUNPOWER®

SunPower® E-Series Commercial Solar Panels | E20-327-COM

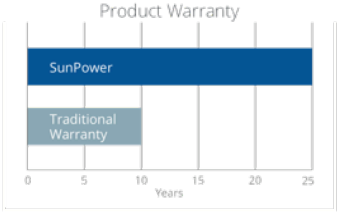
Sunpower Offers The Best Combined Power And Product Warranty

Power Warranty



More guaranteed power: 95% for first 5 years, -0.4%/yr. to year 25. [7]

Product Warranty



Combined Power and Product defect 25 year coverage that includes panel replacement costs. [8]

Electrical Data

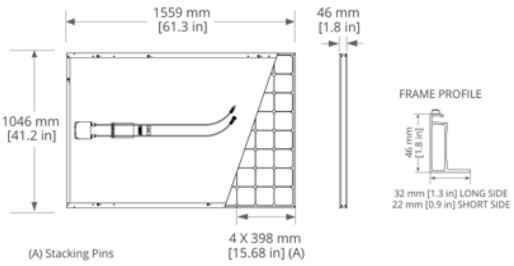
	SPR-E20-327-COM	SPR-E19-310-COM
Nominal Power (Pnom)[11]	327 W	310 W
Power Tolerance	+5/–3%	+5/–3%
Avg. Panel Efficiency[12]	20.3%	19.3%
Rated Voltage (Vmpp)	54.7 V	54.7 V
Rated Current (Impp)	5.98 A	5.67 A
Open-Circuit Voltage (Voc)	64.9 V	64.4 V
Short-Circuit Current (Isc)	6.46 A	6.05 A
Max. System Voltage	1000 V UL & 1000 V IEC	
Maximum Series Fuse	15 A	
Power Temp Coef.	–0.38% / °C	
Voltage Temp Coef.	–176.6 mV / °C	
Current Temp Coef.	3.5 mA / °C	

Tests And Certifications

Standard tests[13]	UL1703 (Type 2 Fire Rating), IEC 61215, IEC 61730
Quality Certs	ISO 9001:2008, ISO 14001:2004
EHS Compliance	RoHS, OHSAS 18001:2007, lead free, REACH SVHC-155, PV Cycle
Sustainability	Cradle to Cradle (eligible for LEED points)[14]
Ammonia test	IEC 62716
Desert test	10.1109/PVSC.2013.6744437
Salt Spray test	IEC 61701 (maximum severity)
PID test	Potential-Induced Degradation free: 1000V[9]
Available listings	UL, CEC, CSA, TUV, JET, MCS, FSEC

Operating Condition And Mechanical Data

Temperature	– 40°F to +185°F (– 40°C to +85°C)
Impact resistance	1 inch (25mm) diameter hail at 52 mph (23 m/s)
Appearance	Class B
Solar Cells	96 Monocrystalline Maxeon Gen II
Tempered Glass	High transmission tempered Anti-Reflective
Junction Box	IP-65, MC4 Compatible
Weight	41 lbs (18.6 kg)
Max load	Wind: 2400 Pa, 50 psf front & back Snow: 5400 Pa, 112 psf front
Frame	Class 2 silver anodized; stacking pins



Please read the safety and installation guide.

REFERENCES:
1 All comparisons are SPR-E20-327 vs. a representative conventional panel: 250W, approx. 1.6 m², 15.3% efficiency.
2 Typically 7-9% more energy per watt, BEW/DNV Engineering "SunPower Yield Report," Jan 2013.
3 SunPower 0.25%/yr degradation vs. 1.0%/yr conv. panel. Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, Feb 2013; Jordan, Dirk "SunPower Test Report," NREL, Q1-2015.
4 "SunPower Module 40-Year Useful Life" SunPower white paper, May 2015. Useful life is 99 out of 100 panels operating at more than 70% of rated power.
5 Second highest, after SunPower X-Series, of over 3,200 silicon solar panels, Photon Module Survey, Feb 2014.
6 8% more energy than the average of the top 10 panel companies tested in 2012 (151 panels, 102 companies), Photon International, Feb 2013.
7 Compared with the top 15 manufacturers. SunPower Warranty Review, May 2015.
8 Some restrictions and exclusions may apply. See warranty for details.
9 5 of top 8 panel manufacturers tested in 2013 report, 3 additional panels in 2014. Ferrara, C., et al. "Fraunhofer PV Durability Initiative for Solar Modules: Part 2". Photovoltaics International, 2014.
10 Compared with the non-stress-tested control panel. Atlas 25+ Durability test report, Feb 2013.
11 Standard Test Conditions (1000 W/m² irradiance, AM 1.5, 25° C). NREL calibration Standard: SOMS current, LACCS FF and Voltage.
12 Based on average of measured power values during production.
13 Type 2 fire rating per UL1703:2013, Class C fire rating per UL1703:2002.
14 See sales person for details.

See http://www.sunpower.com/facts for more reference information.
For more details, see extended datasheet: www.sunpower.com/datasheets.

Document # 505701 Rev F /LTR_US

SUNPOWER®

APPENDIX B – PV TRACKING FRAMES

STG International

T-PV 1

SINGLE AXIS TRACKING PV FRAME

TECHNICAL SPECIFICATIONS

Overview

The T-PV1 is an auto-tracking photovoltaic panel single axis rotating frame with a modular design allowing for the configuration of PV array systems for a range of scales, from single module demonstration units of up to 2.4kWp to solar array fields consisting of blocks of 16 modules (up to 38kWp each). Sun-tracking enables the panels to face towards the sun as it moves east to west at a tilt angle that minimizes the angle of incidence cosine losses. A single frame can support a panel aperture area of 14m^2 on peripheral drive half wheels for geared single axis sun tracking in a 280° field of view. The each tracking module is designed for use with up to six standard 72-cell PV panel modules, and the mounting base requires minimal site civil works to install on precast concrete footing plinths. Auto-tracking is achieved using a low-cost Arduino-based control system featuring a sun position algorithm and inclinometer sensor feedback.

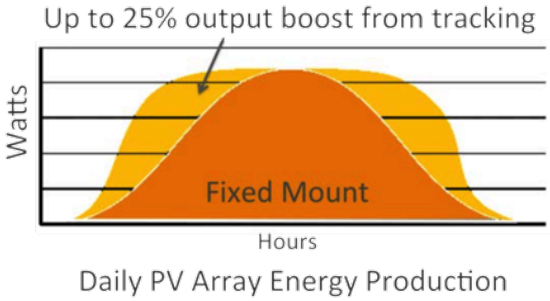
www.stginternational.org

T-PV 1

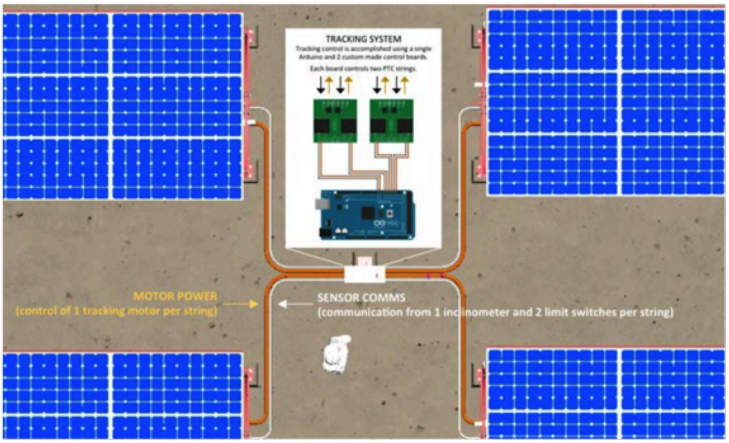
SINGLE AXIS PV TRACKING FRAME

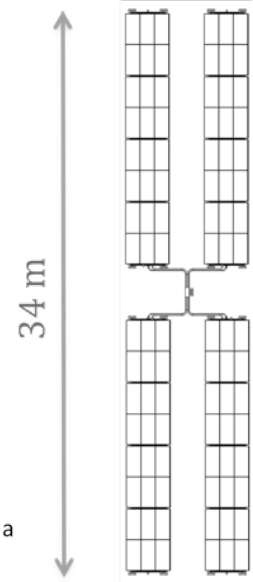
General System Data

Specifications	Value
Frame Length	4m
Frame Width	2m
Max PV Area per frame (gross)	14 m²
Operating Temperature Ranges	-10-50°C
Tracking module weight	100 kg
Total acceptange angle	280 deg
Maximum Wind Speed (stowed)	150 km/h
Maximum Wind Speed (tracking)	50 km/h



Individual modules can be grouped together in rows of four tracking frames, with up to 4 rows (16 T-PV1 units) operated from a centrally mounted row controller.





The pricing in the following table is calculated for on a per module basis for a system comprising 4 strings of 4 T-PV1 modules each (16 T-PV1 modules):

- Low Volume Manufacturing (prototype scale)
- High Volume Manufacturing (Multiple systems where scale enables mass-production manufacturing estimates to be used)

	Low Volume Pricing	High Volume Pricing
	T-PV1 Frame	T-PV1 Frame
Per T-PV1 Module Cost (USD)	1 900 USD	1 600 USD
Per Wp Cost (USD/W)	0.8	0.66

Number of Modules	Max Output [kWp]	Average Energy [kWh/day]
1	2.4	18
4	9.6	72
8	19.2	144
16	38.4	288

www.stginternational.org

APPENDIX C – POWER ELECTRONICS

YASKAWA
SOLECTRIA SOLAR

UTILITY-SCALE INVERTERS

SGI 500XTM
SGI 750XTM

FEATURES

- Compliant with NEC 2014 690.11 & 690.12 arc-fault and rapid shutdown requirements when coupled with ARCCOM combiner
- 98% CEC efficiency
- 1000 VDC
- Parallel power stages
- Fuse and breaker subcombiner options
- Modbus communications
- User-interactive LCD

OPTIONS

- Stainless steel enclosure
- Web-based monitoring
- Built-in cellular connectivity
- AC breaker with shunt trip
- Revenue grade metering
- Air filters
- Uptime guarantee

OPTIONS FOR UTILITIES

- Real power curtailment
- Reactive power control
- Voltage ride through
- Frequency ride through
- Controlled ramp rates
- DMS tie-in
- Rule 21 compliant

SOLECTRIA.COM

1000VDC UTILITY-SCALE INVERTERS

The only 1000VDC inverter available that is compliant with NEC 2014 690.11 & 690.12 arc-fault and rapid shutdown requirements. Yaskawa - Solectria Solar's SMARTGRID series inverters are optimized for high efficiency, reliability, and economy. Available in two power classes, 500 kW and 750 kW, these inverters are designed for direct connection to an external transformer for large commercial or utility-scale applications. They are robust, outdoor rated inverters that can be configured as 1 or 1.5 MW Solar Stations. Available utility-scale options include advanced grid management features such as voltage and frequency ride through, reactive power control, real power curtailment and power factor control. Listed to 1000 VDC with 98% CEC weighted efficiency, the SGI 500/750XTM inverters set a new standard for large scale power conversion.

SPECIFICATIONS	SGI 500XTM	SGI 750XTM
DC Input		
Absolute Maximum Input Voltage	1000 VDC	
Max Power Input Voltage Range (MPPT)*	545-820 VDC	
Operating Voltage Range	545-1000 VDC	
Maximum Operating Input Current	965 A	1445 A
Strike Voltage	700 V	
AC Output		
Native Output Voltage	380 VAC, 3-Ph	
AC Voltage Range	-12/+10%	
Continuous Output Power	500 kW	750 kW
Continuous Output Current	760 A	1140 A
Maximum Backfeed Current	0 A	
Nominal Output Frequency	60 Hz	
Output Frequency Range	57-60.5 Hz	
Power Factor	Adjustable - 0.8 to +0.8, factory set at 1	
Total Harmonic Distortion (THD) @ Rated Load	‹ 3%	
Efficiency		
Peak Efficiency	98.3%	
CEC Efficiency	98.0%	
Tare Loss	89 W	123 W
Subcombiner Options		
Fuses	4 to 16 positions, 100-400 A	
Breakers	4 to 15 positions, 125-350 A	
Temperature		
Ambient Temperature Range (full power)	-40°F to +122°F (-40°C to +50°C)	
Storage Temperature Range	-40°F to +122°F (-40°C to +50°C)	
Relative Humidity (non-condensing)	5-95%	
Data Monitoring		
Optional SolrenView Web-based Monitoring	Integrated	
Optional Revenue Grade Monitoring	800 A	1600 A
Optional SolZone™ Sub-Array Monitoring (DC Current)	1 zone per protected input (up to 16 zones)	
Optional Cellular Communication	SolrenView AIR	
External Communication Interface	RS-485 SunSpec Modbus RTU	
Testing & Certifications		
Safety Listings & Certifications	UL 1741/IEEE 1547, CSA C22.2#107.1	
Testing Agency	ETL	
Warranty		
Standard	5 year	
Optional	10, 15, 20 year; extended service agreement; uptime guarantee	
Dedicated External Transformer		
Dedicated External Transformer	Required, provided by customer to Solectria's specification	
Transformer Type	Self cooled, step up, pad mount	
Output Voltage	Typical: 2.4-36.0 kV, 3-Ph	
Enclosure		
dBA (Decibel) Rating	‹ 67 dBA @ 10 m	
DC Disconnect (integrated)	Standard	
AC Disconnect/Breaker (integrated)	Optional disconnect, breaker or breaker with shunt trip	
Dimensions (H x W x D)	82 in. x 109 in. x 41 in. (2083 mm x 2769 mm x 1042 mm)	
Shading Set Back	137" (3480 mm) at 30° solar elevation	
Shipping Weight	3080 lbs (1398 kg)	3570 lbs (1620 kg)
Enclosure Rating	Type 3R	
Enclosure Finish	Polyester powder coated steel; optional 316 stainless steel	

*At nominal AC voltage

YASKAWA SOLECTRIA SOLAR www.solectria.com | inverters@solectria.com | 978.683.9700

MADE IN THE USA

APPENDIX D – LETTERS FROM STAKEHOLDERS REGARDING LAND ACCESS

Letter of Support

for

Development of 20MW Solar Photovoltaic Power Generation

MEM/SOL-001/2016/17

Re: Land Access Commitment **Date:** 23/03/16

To the tender committee of the Ministry of Energy and Meteorology:

I, Kaiyous, hereby attest that I represent the landholding interests and the authority and right to assign, through sale or lease, the property located in Ha Ramarothole, in the Ts'ana Talana council of the Mafeteng district, at approximate GPS coordinates (-29.8034722, 27.3429061), comprising up to 40 hectares of farmland.

I furthermore affirm that the OnePower consortium has approached me with an offer to negotiate fair compensation for transfer of this land parcel to OnePower for the purposes of constructing and operating a solar power plant for a period of no less than 50 years. In addition to compensation for transfer of land rights, during the construction and operation of this power plant, OnePower has committed to benefit the community that I represent in the following ways:

- By employing, where possible, the workers of this community in supporting roles as needed in scope of the project, at fair wages.
- By undertaking reforestation around the perimeter of the plant for the benefit of the community.
- By practicing land restoration and water management at the facility including rainwater harvesting and the creation of a dam external to the facility for use by the community as a water source.
- By interceding, on behalf of the community, with LEC for the extension of grid electricity connections to the community or, if that is not practicable, by seeking permission from LEWA for creating a mini-grid electricity distribution network serving the community with prepaid electricity service provided by OnePower at a cost-reflective tariff.

I affirm that, having considered this proposal, I am willing and interested to provide this land to OnePower for the above stated purposes, pursuant to a compensation package that will be determined in a timely manner through a consultative process with OnePower, the community, and legal representatives.

Thank you for considering our community for this project. With highest regards.

Name: Kaiyous Ramarothole

Signature: K. Ramarothole

Position: Chief

Witnessed by:

Name: LESOME MOHAPI

Signature: MOHAPI

MORENA OA HA RAMAROTHOLE
LIKHOELE
23 MAR 2016
Ramarothole
MAFETENG, LESOTHO

Letter of Support

for

Development of 20MW Solar Photovoltaic Power Generation

MEM/SOL-001/2016/17

Re: Land Access Commitment **Date:** 23-03-2016

To the tender committee of the Ministry of Energy and Meteorology:

I, Mollatsi Tjanela, hereby attest that I represent the Community Council of Ts'ana Talana, Mafeteng. I affirm that the OnePower consortium has made the Council aware of the project 'Development of 20MW Solar Photovoltaic Power Generation' and of its interest in purchasing or leasing property. The property of interest an area of up to 40 hectacres, located in the Ts'ana Talana council of the Mafeteng district at approximate GPS coordinates (-29.8034722, 27.3429061). I further affirm that OnePower has discussed the matter with the council and village chiefs of Ts'ana Talana and Mafeteng, respectively, and that all appropriate parties have given approval to negotiate an agreement.

OnePower has offered to negotiate fair compensation for transfer of this land parcel for the purposes of constructing and operating a solar power plant for a period of no less than 50 years. In addition to compensation for transfer of land rights, during the construction and operation of this power plant, OnePower has committed to benefit the community that I represent in the following ways:

- By employing, where possible, the workers of this community in supporting roles as needed in scope of the project, at fair wages.
- By undertaking reforestation around the perimeter of the plant for the benefit of the community.
- By practicing land restoration and water management at the facility including rainwater harvesting and the creation of a dam external to the facility for use by the community as a water source.
- By interceding, on behalf of the community, with LEC for the extension of grid electricity connections to the community or, if that is not practicable, by seeking permission from LEWA for creating a mini-grid electricity distribution network serving the community with prepaid electricity service provided by OnePower at a cost reflective tariff.

On behalf of the Community Council, I affirm that I am interested in working with OnePower in its effort to develop a solar power plant in Ts'ana Talana. Thank you for considering our community for this project. With highest regards,

Name: Mollatsi Tjanela

Signature: Tjanela

Position: for CCS

TSANATALANA EOS
COMMUNITY COUNCIL
23 -03- 2016
P.O BOX 893
MAFETENG • 900 • LESOTHO

Witnessed by:

Name: T. D. Letsoela

Signature: