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PROPOSED AMDA DELTA SOLAR PV POWER PLANT

DEVELOPER INPUT

PURPOSE

The purpose of this report is to provide a project description and the background to the development process as input for the EIA process.

PROPOSED AMDA DELTA SOLAR PV DEVELOPMENT

AMDA Developments proposes to develop the AMDA DELTA 75MWe solar PV power plant at the Klondike site just west of Vryburg in the North West Province and is in the process of securing the development rights, consents and authorisations necessary to bid the project in the Department of Energy's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP).

SITE SELECTION

In choosing a site for the development of a solar PV project we, as the developer, go through a process of evaluating a number of possible alternative sites in terms of the criteria that would make a viable site worth bidding in the REIPPPP.

The REIPPPP is a very competitive program and a site that is marginally less suitable from a solar resource or development cost perspective has less chance of securing a successful bid. Therefore as developers, we put a lot of effort into evaluating and selecting the best available sites.

The Department of Environmental Affairs, together with other State Departments have gone through a Strategic Environmental Assessment process which has resulted in the creation of Renewable Energy Development Zones (REDZ). These REDZ's are a guideline as to where it is appropriate to develop renewable energy projects but the development of renewable energy projects is not restricted only to these areas. It is therefore still important to evaluate individual sites within or across these REDZ's and other areas to determine and select the most competitive sites. Cabinet on Wednesday, 17 February 2016, approved the 8 Renewable Energy Development Zones (REDZ) and 5 Power Corridors. The proposed AMDA Delta Solar PV power plant falls within the Vryburg REDZ 6 zone.

The main criteria used in the evaluation of the alternative development sites are; a good solar resource, proximity to the Eskom grid, availability of Eskom grid capacity, a flat open site, sufficient development space, no mountains nearby, low value land, low agricultural potential, low environmental sensitivity, availability of water and the land must be available for development.

A good solar resource. Most sites in or near the Kalahari have a very good solar resource and the resource reduces as you move away from this area. For example, the solar resource for a PV project at Kenhardt in the Northern Cape is 8 – 10% better than at Beaufort West in the Western Cape. This difference makes it very difficult to do a competitive bid at Beaufort West.

A site should preferably be adjacent to or close by to a point where it can connect to the Eskom grid. Connection lines of up to a few kilometers can still be competitive.

The Eskom grid has to have the capacity, at the grid connection point, to evacuate the power from the project. If any extensive grid strengthening needs to be done to evacuate the power this grid upgrade is done at the cost of the project and thus the project is less likely to be competitive.

Also at issue here is that the time taken to select, sign up, permit and bid a project is usually longer than the interval between successive REIPPPP bids. There is thus the risk that other projects might take up the available grid capacity in the time the project is being permitted and the project might have to be abandoned.

The project design and layout can be optimized on a flat open site as no special or expensive adjustments need to be made for shadow effects between the various components. The proximity of mountains can reduce the yield at a site. Land with a gentle northwards slope is also suitable.

Sufficient space allows for the optimization of the layout, but more importantly if there is sufficient space for multiple projects the economies of scale can lead to very competitive bids.

Land with a high agricultural potential should not be used for the development of a solar PV project as food security outranks energy security. Arable land with the appropriate rights to water for irrigation is deemed to have high agricultural potential.

A site with a low land value will allow a cost effective lease price and hence a more competitive bid.

Sites without any significant environmental sensitivities allow for development optimization without any costly layout constraints or design precautions. Environmental sensitivities include floral, faunal (including avifaunal) sensitivities as well as the existence or proximity to water courses or wetlands.

Water is needed for the construction and operational stages of a project. The solar PV projects use a low volume of water during the operational phase and so securing this water is usually not an issue. During the construction stage more water is needed and the water often needs to be obtained from distant sources and transported to site.

STUDY AREA SELECTION

The area required for the development of the PV plant is determined by a number of factors. Given that these sites are mostly flat, with a northern orientation, the key factors determining the size of the site needed are the desired production capacity of the plant and the specific technology chosen.

The density of development is highest for fixed rack systems and lowest if two axis trackers are used. Typically fixed rack systems would take up about 2 to 3 Ha/MW and a PV plant using trackers would need about 4.5 to 6 Ha/MW. The current trend highly competitive REIPPPP market imply that either fixed structures or horizontal single axis tracking systems will most likely be used. Thus the 75MW plant should use about 225Ha.

For purposes of an EIA it is wise to investigate a larger area than required for the PV plant envisaged for the application. This is in order to provide for sufficient space for the chosen technology and for flexibility in the positioning and detail layout of the plant in response to on site or environmental conditions or for design optimisation.

PROJECT SUMMARY - MAIN FEATURES

The proposed PV plant will convert the incident solar energy into direct current (DC) electricity by means of photovoltaic modules. The electricity is transferred to DC/AC inverters to convert it to alternating current (AC). The inverters are matched to the selected PV module technology, and in turn are connected to a step-up transformer in order to raise the voltage up to the grid requirements.

The Engineering, Procurement and Construction (EPC) will be carried out by an EPC Contractor in accordance with good engineering practice, with due diligence, care and professionalism. The design of the facility and the selection of equipment will be tailored for the specific site conditions, such as solar resource and climate etc.

Photovoltaic power plants have a wide range of technologies that can be considered for incorporation into the plant. During the EIA and bid process the developer will put out a Request for Offers (RFO) from credible EPC Contractors who will make proposals with respect to the technology to be used and possible equipment suppliers for the PV plant. These include the PV module manufacturer, the type and capacity of the modules, the support structure or tracker type, and manufacturer, the inverter type, etc. Some of these alternatives are discussed in more detail below.

The solar PV industry is a rapidly developing industry and the advances in the general efficiencies of the technology and also the reduction of production costs are such that it would not be feasible to commit to specific technologies and manufacturers at this stage. The average bid price for solar PV projects decreased from R2.75/kWh to about R0.75/kWh between Round 1 in October 2011 and Round 4 in 2015 respectively.

Therefore the project description will be in generic terms and will not specify specific brands and capacities.

GENERAL LAYOUT DESIGN CRITERIA

The choice of the technology or more specifically, the PV module and tracker or rack structure is the chief determinant in the layout of the PV plant. Fixed rack structures, single and two axis trackers all have different spatial requirements.

An optimised layout or spatial arrangement of the solar field is prepared based on the performance criteria and spatial requirements of the preferred equipment choices above taking into account the further design criteria listed below.

- 16 m from the centre of any power lines, either they are single power lines or double power lines
- 95 m from the centre of provincial roads (a relaxation to a lesser distance can be sought)
- 16 m to any Telkom line
- A minimum distance of 10 m to the perimeter fence to prevent theft and avoid shadows cast by the fence
- Internal and perimeter service roads of 3m surface width and 5 m reserve width
- A main access road with a 10 m reserve width

FOUNDATIONS

A geotechnical study will be carried out in order to provide data for the selection of the foundation. Depending on the structure or tracker that is selected, the following foundation options may be considered.

- Mass concrete block foundation
- Ground screw foundation
- Ground bolt foundation
- Concrete pile foundation
- Vibratory driven steel pile foundation

For fixed or rack structures, either driven steel piles or small concrete footings are cast in the ground for the foundations. These concrete foundations are typically of the same size as for small buildings.

The preferred technology for trackers is the vibratory driven steel pile foundation. This might be achievable on this site, however in localised areas with hard ground conditions, a steel pile in concrete in a pre-drilled hole is the more likely foundation solution. A concrete pile may also be used.

STRUCTURES

In order to support the PV modules, a steel structure must be used. There are different options which will be considered: a fixed or rack structure, a 1-axis tracker (horizontal, vertical or polar axis) and a 2-axis tracker. The current trend is towards rack structures or horizontal single axis trackers because of the superior production rates and cost effectiveness.

There are numerous rack and tracker manufacturers in the market, many with proprietary technology and the system chosen will depend on the proposals by the EPC Contractors.

The materials commonly used in support and tracker structures are:

- Galvanized steel
- Stainless steel
- Anodized aluminium

Fixed or rack structures

A typical rack or fixed structure will usually have two rows of 20 modules (2 strings). The modules are placed in portrait arrangement. The foundation technology is usually a direct-driven (rammed) installation, with a ramming depth subject to the soil characteristics.

The design of the fittings for fixing the modules to the rack structures will enable thermal expansion of the metal without transferring mechanical loads that could affect the integrity of the modules. The structure will probably have anti-theft bolts.

Single-axis trackers

With a typical horizontal single-axis tracker the PV modules are attached to beams on the rotating structure. A number of these beams are placed adjacent and parallel to each other and driven by a common rotation mechanism. This allows for a modular design with each tracker module having a single central motor and a number of tracker arms. This simplifies design and allows for an extremely efficient use of space.

The system produces more output than rack structures yet still has extremely low energy consumption.

Precision electronics with GPS input and proprietary positioning algorithms ensure that the PV modules are positioned at an optimum angle to the sun at all times.

STI-Norland tracker

PV MODULES

There are various types of PV modules defined according to the materials and technology used:

- Si-Monocrystalline
- Si-Polycrystalline
- Thin Film
- High Concentrated

There are also a wide range of PV module manufacturers in the market. Currently the trend for utility scale facilities such as this is towards polycrystalline module technology.

In the REIPPPP an important bid criteria is local content and the use of locally manufactured or assembled PV modules to help the local economy, local job creation and the local communities.

The EPC Contractor establishes rigorous quality control procedures for the PV modules suppliers. These procedures are applied from the source of the supply, as well as during the entire supply chain.

Since the environmental impact of the various PV module alternatives will be the same, for the purpose of the EIA, all of the abovementioned film technology alternatives are under investigation.

INVERTERS

There are various types of inverters defined according to their technology. The inverter will be selected on the basis of making the most of its rated power according to the manufacturer specifications and the power to be installed in each site. The choice of inverter depends on the performance of the PV module chosen (type and model) and the size (capacity).

The number of inverters to be used is determined in a design optimisation process where there is a trade-off between fewer large capacity inverters or more lower capacity inverters widely distributed across the solar field. Typically there would be about 2250 inverters used in a 75MW PV project.

CONCENTRATOR BOXES

The concentrator boxes are outdoor switchgear boxes or cabinets where the electrical wires from the tracker or rack group are collected. The concentrator boxes are designed for outdoor conditions and are mounted on a concrete base.

TRANSFORMATION CENTRE

The transformation centre will be a concrete or steel prefabricated structure built to house the transformer and the associated protection devices. In the transformer, voltage level will be transformed from 0.38 kV to 132 kV. This might be done in a single step or in multiple steps, for example from 0.38 kV to 11 kV and then from 11 kV to 132 kV .

The number of transformers to be used is determined in a design optimisation process where there is a trade-off between fewer large capacity transformers or more lower capacity transformers widely distributed across the solar field. Typically there would be about 75 transformers used in a 75MW PV project.

DISTRIBUTION CENTRE

The distribution centre is where all the medium voltage lines coming from the various transformers are collected. The distribution centre also houses the meters used to measure the electricity produced and exported to the grid. The distribution centre is housed in a pre-fabricated or a steel structure and a MV line runs from here to the collector sub-station and from there to the Eskom substation.

ELECTRICAL RETICULATION

The electrical reticulation within the PV plant, from the trackers or racks through to the distribution centre will all be underground.

The electrical reticulation will comprise of a Direct Current (DC) component from the PV modules to the inverters and an Alternating Current (AC) component from the inverters to the Eskom connection.

Typically the DC cabling is based on pre-assembled harnesses from each string-end connection up to the concentrator boxes. The harnesses incorporate a first-level over-current protection by means of properly sized line- fuses. The DC cable will be in full compliance with IEC and SANS standards, with single layer of XLP insulation, 90º temperature rating (wet or dry), suited for direct burial installation, rated for 1kV and UV resistant.
Typically, the cables will be sized to ensure a maximum 1.5% voltage drop between PV modules and inverters.

Typically the AC-MV cable will be in full compliance with IEC, SANS and NRS Standards, with stranded aluminium conductor, triple extruded insulation system and high dielectric strength 22kV insulation. The MV cables will be suited for direct burial, for operation at 105°C continuous, 140°C in emergency and 250°C in short-circuit.

EVACUATION LINE

The electricity from the PV power plant will be evacuated via a 132kV overhead line to the new collector sub-station on the site and from there to the Eskom grid at their Mookodi sub-station. The connection point for the evacuation line will be determined by the Eskom grid connection requirements and the line will be designed and built to Eskom's standards.

The alignment of the evacuation line will be determined by the proposed grid connection point and any environmental sensitivities between the PV power plant and the grid connection point. The EIA will assess the evacuation line as a corridor, rather than a static line.

LIGHTINING PROTECTION SYSTEM

To protect the PV plant, equipment and personnel from lightning strikes a lightning protection system composed of masts and surges arresters will be installed. This system will be designed by a specialist and will comply with the South African laws and standards.

Although current lightening protection designs only allow for low height protection on the individual structures, provision has been made in the applications for 15m high conductor masts.

AUXILARY POWER SUPPLY

The PV plant requires a continuous power supply for the operation of the plant. This is for the plant monitoring and control systems, the perimeter and security systems, lights and air-conditioning etc for the buildings. Also if trackers are used, a small supply is required for the operation for the trackers.

The most cost effective and efficient source is for the auxiliary power supply is usually directly from the Eskom sub-station. The project can possibly connect to one of the existing 11kV supply lines which cross the property.

EMERGENCY POWER SUPPLY

In order to ensure the continuous operation of the monitoring system and security a backup diesel generator system, with at least 2 hours of autonomy, is usually installed.

MONITORING & CONTROL SYSTEMS

A SCADA (Supervisory Control And Data Acquisition) system will be installed. The primary purpose of SCADA is to monitor, control and alarm plant or regional operating systems from a central location. While override control is possible, it is infrequently utilized.

There are three main elements to a SCADA system, various RTU's (Remote Telemetry Units), communications and an HMI (Human Machine Interface).

Each RTU effectively collects information at a site, such as from the inverters or met station, while communications bring that information from the various plant or regional RTU sites to a central location, and occasionally returns instructions to the RTU.

The HMI displays this information in an easily understood graphics form, archives the data received, transmits alarms and permits operator control as required. The HMI is essentially a PC system running powerful graphic and alarm software programs.

Communication within a plant will be by data cable, wire or fibre-optic, while regional systems most commonly utilize radio or the internet. The real time information can be monitored remotely, typically by the O&M company and the plant owners etc.

MET STATIONS

There will be a number of meteorological stations installed on the site in order provide adequate meteorological data to evaluate the PV plant performance. The typical meteorological station will include all or some of the following items:

- Lattice structure 3m high for the support of the systems
- pyranometer for tilted radiation
- horizontal pyranometer for global radiation
- ambient temperature sensor with natural ventilation antiradiant shield
- anemometer at 5m height
- a vane to measure the wind direction
- module temperature sensor
- humidity sensor
- data logger
- GSM/GPRS modem
- UPS or non-stop power supply system

SITE PREPARATION

Owing to the relatively open or expansive nature of the PV plant and hence the construction process, no specific service or haul roads are envisaged. The site will be sufficiently cleared to allow access for the excavation equipment and the rough terrain vehicles that will deliver the site assembled PV rack or trackers structures to their positions.

Vegetative ground cover reduces dust which influences the PV panel efficiency. The re-growth of the ground cover or rehabilitation is thus important to the PV plant. It thus makes sense to minimise the disruption of the existing vegetative ground cover.

The portions of the site needed will be cleared, grubbed and graded by means of the necessary cuts and fills in order to condition the terrain to the maximum slopes allowed for buildings, roads and racks. Given the flat nature of the site there is very little cut and fill envisaged.

TRENCHES

Depending on the number of cables that run in each trench and the voltage level, the dimensions of the trenches can vary. The typical width is 0.6 m and depth is from 0.6m to 1.10 m. The cable or cables are laid in a suitable bedding material, usually sand. If the in-situ material is not suitable for bedding, then bedding material will be sourced from local commercial sources. The trenches are then backfilled using suitable material that came from the trench excavations.

Trenches are usually excavated by a TLB or an excavator if the ground is hard, but given the quantity of trenching within the PV plant specialist trenching machines might be used.

ACCESS AND INTERNAL ROADS

The proposal is that access to the site will be either via the existing access to the farm from the N14 or a new access road from the existing Vryburg – Reivilo District Road. This gravel road will serve as the access point for the proposed cluster of solar PV developments.

The access off the District Road will be designed and built to the Road Authority’s standards. The Road Authority’s consent will be sought during the permitting process and construction will only commence once the detail design and specifications have been approved by the Road Authority.
Sufficient space will be allowed at the access points to ensure that the vehicles do not stack up on the District Road while being processed through security. Also the road alignment and layout will take into account the necessary safety precautions.

The common access and internal roads shall be constructed as all-weather type, the common access road will be 6m wide and the internal roads 3m wide, all with wide, open side drains forming part of the drainage system.

Passing bays will be provided at strategic points on the access road to allow the circulation of two trucks in opposite directions at the same time during the construction and operational phases.

The roads will be built with a minimum of 400mm depth of sub-grade preparation and an aggregate base layer of up to 150mm thick compacted to the 95% Proctor (AASHTO). The base layer will either be of material obtained from the excavations on site or aggregate from a commercial source.

The road layout will be designed in order to ensure ease of access to every rack or tracker structure and the horizontal geometry will be designed to enable the turning of trucks and construction vehicles.

The design process will investigate surfacing some of the roads to minimise dust.

During the operational phase access around the site is generally only required for security and routine inspection. Access for cleaning operations or maintenance is very infrequent, thus the internal service roads need only be gravel tracks.

DRAINAGE

The stormwater drainage system proposed will be a surface management system based on not collecting and concentrating the storm-water but rather spreading or distributing it over the site to soak away or drain slowly. This avoids the soil erosion and downstream flooding problems normally associated with the concentrated flows.

The design should allow the flows to be similar to the normal pre-development flows.

The detail drainage and stormwater surface management design will be done during the detail planning stage.

A Stormwater, Washwater and Erosion Management Plan will be developed and will form part of the Environmental Management Plan for the facility.

BUILDINGS & SERVICES

The buildings and facilities needed to service a PV plant are; a control room (20m^2), a small office (30 m^2), a meeting room (30 m^2)ablution facilities and kitchen area (20 m^2), a small workshop (40 m^2) and a store of 300 to 400 m^2. There will also be facilities for the security personnel on the site. There is space allocated in the PV plant layout for the buildings near the entrance to the site.

One option is to build a farm type shed of approximately 500 m^2 (40m x 12,5m) with the control room and offices etc inside the building. However, given that the electricity generating license has a 20 year term the trend is to provide temporary buildings such as Park-Homes or containers.

Services for the buildings are provided as follows.

- Electricity will come from the Eskom sub-station.
- The control room and the office will have air-conditioning
- Enviro-loo toilets will be used. These toilets are used in a number of National Parks and Nature Reserves. The toilets do not require a water supply and operate by separating the solid and water waste and then drying the waste by evaporation. The dry solids are removed and can safely be spread as compost in the field.

- Alternatively a conventional waterborne sewerage system could be installed draining to a conservancy tank. The effluent would be routinely collected and transported to the Local Authority's waste water treatment works for processing.
- The source for the small amount of potable water required for use by the site personnel will need to be determined during the planning process. See below.

Should the available water need treatment then the appropriate plant and equipment will established on site and used.

PARKING AREA

There will be small a hardstand parking / lay-down area near the buildings, to be used for the operational phase.

PERIMETER FENCING

Given the high material values and risk of theft associated with PV panels and electrical cabling it is imperative that the perimeter fences and security systems get installed and commissioned as soon as is practical. This is especially so before the electrical reticulation is operational when the materials are easier to steal.

The process will be to first fence off a delivery, storage and processing area within the site as a start and then to erect the perimeter fence and security. This will allow the initial construction start up activities to begin earlier.

The proposed perimeter fence is 2.4 m weld-mesh or wire and netting fence which is electrified or a 2.4m high electric fences with only electric strands. The electrification will be non-lethal and non-electrified outlier wires will be placed to each side of the fence to prevent small animals getting stuck under the electric fence.

A single 6m automated sliding gate will be provided for vehicular access as well as a single 1m wide gate for pedestrians.

SECURITY SYSTEM

The perimeter, access points and general site will be monitored by CCTV cameras infrared / night vision technology and passive intrusion detection systems. There will be security lighting which will be linked to the passive intrusion detection systems so will not be on all night.

OPEN SPACE AND FIRE MANAGEMENT

A firebreak of the appropriate width will be established and maintained both inside and outside of the perimeter fence. The internal perimeter road will form part of the firebreak.

An open space and veld fire management plan will be drafted and included in the Environmental Management Programme for the project. This management plan will need to be aligned with the erosion and the invasive alien plant management plans as they are inextricably linked.

WATER USAGE DURING CONSTRUCTION PHASE

The temporary water requirement for the construction stage of the PV plant is mainly for the production of concrete for the structure and tracker foundations, for road construction and for general construction processes and dust control etc.

About 9Ml would be needed for the construction stage of a 75MW solar PV plant. This equates to an average draw down rate of about 80kl per day during the construction period.

Possible sources for this water are to be investigated and the relevant authorities will be approached during the EIA process.

WATER USAGE DURING OPERATIONAL PHASE

A PV Plant does not require much water for operation. The main requirements are water for the domestic needs of the security and operational personnel and for the cleaning of the PV panels.

Possible sources for this water are to be investigated and the relevant authorities will be approached during the planning stage, concurrent to the EIA process. Noting that the majority of the water is required for cleaning, the water could be obtained from the Local Authority and brought to site by a vehicle equipped especially for the cleaning operation. The water for the “domestic” use could similarly be transported to site.

Based on the metered water usages at our existing facilities near Douglas in the Northern Cape, a 75MW PV plant would require about 1600kl per annum for general and office use during the operational phase and a further 525kl for washing the PV modules. This is for two washes per year at 3,5kl per MW capacity per wash. A total of about 2225kl per year ins needed.

Note that the amount of potable water required during the operational phase usually does not trigger a Water Use License, however if the water is not sourced from a Registered Water Service Provider the water use will need to be registered.

PHASES OF THE PROJECT

CONSTRUCTION PHASE

The construction phase includes all the varied activities and operations needed to develop a fully operational PV power plant. As an example, but not limited to, the following activities will occur on site in the construction phase:

- Temporary fencing of the construction yard site
- Installation of perimeter fence
- Site clearing as needed – to be kept to a minimum to avoid dust
- Delivery of construction materials and equipment
- Foundation excavation
- Installation of foundation piles
- Installation of electrical reticulation
- Installation of lightning protection system
- Assembly of trackers or racks
- Moving of the assembled trackers or racks to their final position
- Installation and set-up of electrical equipment
- Construction of buildings
- Installation of security system
- Commissioning of the systems
- Commissioning tests

The following areas will be indicated on the concept Site Development Plan. These areas are based on the typical requirements for a PV facility and the final position and exact shape of these areas will be determined during detail planning and design optimisation and can also be affected by site conditions.

- Lay down area
- Assembly area
- Spoil heaps and borrow pit area
- Construction traffic

LAYDOWN AREAS

It is an area needed for the reception of different materials such as PV modules, rack or tracker components, motors, gears, electrical devices, conduiting for wires, transformers, switchgears, prefabricated structures etc.

ASSEMBLY AREAS

It is an area proposed for a safe and fast assembly of the racks or trackers. There, needed materials are laid within the assembly area in order to streamline the assembly process. Once the rack or tracker is preassembled, a rough terrain vehicle will transport the tracker to its final position for the installation process (erection on the foundations, wiring connection, gear mounting… etc).

SPOIL HEAPS AND BORROW PIT AREAS

To the extent that it is possible a balanced cut, borrow, fill and spoil approach will be followed. Thus any material needed in the construction process, be it earthworks, road-works, building foundations or trench backfilling etc. will be sourced from within the development footprint of the site.

Suitable material will thus be sourced from cuts and trenches or any part of the development footprint and the un-suitable material will be spoiled into non-engineered landscaped areas.

Given the relatively small amount of earthworks in the construction process the only spoil envisaged would be material unsuitable to be used in road-works or as backfilling that comes from road-bed, trenches or pile holes. This should be relatively insignificant volumes and can be spread on site.

Should the spoil volume be larger, then landscaped features such as screening berms around the sub-station and PV power plant can be created from the spoil. These would be dressed with suitable soil and planted.

CONSTRUCTION TRAFFIC

During the construction phase the traffic will peak at about 10 large delivery vehicles and 40 to 50 concrete trucks per day while the footings are being cast and then drop to about 20 to 30 large delivery vehicles per day while the electrical reticulation is being installed and the trackers are being erected.

A transportation and Traffic Management Plan will form part of the Environmental Management Programme for the Facility.

OPERATIONAL PHASE

The operational phase includes all operations needed to be carried out to maintain the PV power plant in a full operational mode producing as much electricity as possible and feeding it into the Eskom distribution network.

As an example, but not limited to, the following activities occur in operation phase:

- Checking and verifying of the electricity production
- Maintaining and monitoring a weather station
- Routine inspection of all equipment and systems
- Periodic maintenance
- Periodic cleaning of PV modules
- 24hour security operations

The traffic generated by the PV plant during operation phase once the plant is generating electricity is negligible and will be of the order of four or five vehicles per day.

There will be no residential or overnight accommodation on the site.

DECOMMISSIONING OR UPGRADING PHASE

After the 20 years of operation, the PV plant will either continue to operate or be upgraded if a new license is granted, or the plant will be decommissioned.

Given the degradation of performance of PV modules with time, the plant will function at a lesser export capacity over the new license period.

Upgrading the PV power plant will consist of replacing old PV modules for new ones, increasing the total peak power of the plant (a process called “Repowering”) or increasing the power of the plant by adding new elements such as trackers, PV modules or transformers.

If the plant is to be decommissioned then the site should be returned to close to its original state. Other than the concrete all of the components of a PV plant have an intrinsic value either for re-use or recycling. This intrinsic or scrap value will cover the cost of decommissioning the plant and rehabilitating the site.

- The PV panels will be removed from the trackers and sent to special recycling facilities without further disassembly at the site. The better, functional PV panels can be re-used in less stringent environments.

- The transformers and electrical control devices would either be removed for reuse, with or without re-conditioning, or sold as scrap after removal of the fluids.
- The electrical power management and conditioning equipment would be recycled or disposed of as scrap.
- The underground cable runs could be abandoned in place, or they could be pulled out. The cable has a very high scrap value so the latter is more likely.
- The steel in the fixed rack or tracker structures has high scrap value so these structures will be dismantled and removed for scrap.
- The steel tracker piles can be removed and sold as scrap. Alternatively the steel or the concrete piles can be cut off just below ground level and abandoned.
- The gravel or aggregate in the access road, on-site service roads, in the electrical substations, transformer pads, and building foundations could be removed and recycled for use in other fill operations if not abandoned.
- The buildings can be taken over by the farmer for his operations or all the re-usable material can be removed and the shell demolished and the rubble taken away to a commercial dump site. Temporary buildings can be removed or relocated.

Disturbed land areas can be rehabilitated, the rubble removed, the soil scarified and reseeded or replanted with indigenous vegetation.

Part of the decommissioning and rehabilitation process would be the inspection for and documentation of the presence of industrial wastes in the soil from minor spills or leaks, and decontamination as necessary. If deemed necessary soil testing would be conducted after decommissioning.

Transportation activities during site decommissioning would be similar to but less and of shorter duration than those during site development and construction.