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PROPOSED OLIEN SOLAR PV 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.

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DATE

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PROPOSED OLIEN SOLAR PV DEVELOPMENT

AE-AMD Renewable Energy proposes to develop a 75MW solar PV plant at the Olien site (Ptn 4 of Farm 300, Barkley West) and is in the process of securing the development rights, consents and authorisations necessary to bid the project in the Department of Energy's Independent Power Producer Procurement Programme.

SITE SELECTION

The site selection process was based on locating sites that matched as many as possible of the ideal criteria for the development of a PV electricity generation plant.

These selection criteria will filter out alternative sites which are in some way or other not suitable for the development of a PV electricity generation plant that is environmentally and economically sustainable.

The ideal PV plant site would have the following criteria;

- High solar irradiation area. This allows for the maximisation of the solar energy received.
- Flat to gently sloped terrain. This allows for the optimisation of the layouts and minimum interference with respect to shadows etc, between the individual trackers.
- Northern orientation or no obstructions to the north. This allows for efficiency.
- Not in high potential agricultural land. This avoids conflict with competing activities and the national priority of food security.
- Not in an environmentally sensitive area.
- Suitable ground conditions. This is for the stability of the structures and reduction of construction costs.
- Adjacent to an existing sub-station on the Eskom grid. This avoids the necessity transmission infrastructure.
- Existing capacity at the sub-station and local grid to receive the generated electricity.
- Potential to expand. This is about the sub-station having a reasonable demand growth and there being space for the expansion of the PV plant.

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 production capacity of the plant and the technology used.

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 Independent Power Producer market imply that either fixed structures or horizontal single axis tracking systems will most likely be used. Thus the 75MW plant could use about 225Ha.

For purposes of the EIA it was decided 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 preferred technology and flexibility in the positioning and detail layout of the plant in response to on site or environmental conditions or for design optimisation. To this end the draft Site Development Plan shown is actually for a 100MW fixed rack PV facility and the final 75MW will be smaller than that analysed in the process.

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 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 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 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 R1.75/kWh between Round 1 in October 2011 and Round 2 in March 2012.

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 (or a relaxation to a lesser distance)
- 16 m to any Telkom line
- A minimum distance of 10 m to the 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 of 10 m reserve width

FOUNDATIONS

A detailed 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
- 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. Depending on the ground conditions a concrete pile might need to 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 possibly horizontal single axis trackers because of the superior production rates and cost effectiveness.

There are numerous rack and tracker manufacturers in the market 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 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-AXI TRACKER

With a typical horizontal single-axis tracker the PV modules are attached to beams on the rotating structure. A number of these trackers are placed adjacent to each other and driven by a common rotation mechanism. This allows for a modular design with each module having a single central motor and a number of trackers. 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 optimum angle is controlled at all times.

Figure 2: STI-Norland tracker

PV MODULES

There are various types of PV modules defined according to the materials 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 Independent Power Producer Procurement Programme 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 Contractor establishes rigorous quality control procedures for the PV modules suppliers. These procedures are applied to the origin of the supply, as well as during the supply.

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).

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.

DISTRIBUTION CENTRE

The distribution centre is where all the medium voltage lines coming from the various transformers are collected. The distribution centre is housed in a pre-fabricated or a steel structure and a MV line runs from here 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 guarantee 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 aluminum 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.

The connection from the distribution centre to the Eskom substation depends on Eskom's requirements. This line could be overhead or underground but is more likely to be an overhead 132kV 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.

EMERGENCY POWER SUPPLY

In order to ensure the continuous operation of the monitoring system and security a back up diesel generator system, with at least 2h 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 meteo 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 fiber-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 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, but given the quantity of trenching within the PV plant specialist trenching machines might be used.

ACCESS AND INTERNAL ROADS

Access to the site will be via the existing access to the farm and Eskom sub-station. This access is off the District Road.

Sufficient space will be allowed at the access point to ensure that the vehicles do not stack up on the road while being processed through security.

Access road width will allow the circulation of two trucks in opposite directions at the same time during the construction and operational phases.

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

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.

The design process will investigate surfacing some of the roads to minimise dust. This would include the public as well as access and internal roads.

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 drainage system proposed will be a surface management system based on not collecting storm-water but rather spreading or distributing it over the site to soak away or drain slowly similarly to the normal pre-development flows.

BUILDINGS & SERVICES

The buildings and facilities needed to service a PV plant are; a control room (20m^2), a small office (20 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 480 m^2 (40m x 12m) 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.

- The small amount of potable water required for use by the site personnel can be provided by Sedibeng Water, a registered Water Services Provider who has a pipe-line running along the northern edge of the site.

Should the available water need treatment then the appropriate equipment will be used.

Note that the amount of potable water required is well under the limits required to trigger water use applications.

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 reticulation is operational and hence the materials are less easy 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 double barrier consisting of two 2.4m high electric fences with only electric strands placed about 2 or more metres apart. The electrification will be non-lethal.

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.

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 bases. About 360 lt of water is used for each m^3 of concrete. This is about 180 lt for the concrete mix and about the same again for the general process, construction and dust control etc.

How much concrete and hence water is required depends largely on the technology used.

Based on the worst case requirements of mass concrete foundations 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 60kl per day during the construction period.

Should a single axis tracker system that has a vibratory driven pile foundation type be used then very little concrete other than in the buildings etc will be needed.

Should the ground conditions not be favourable for the driven pile then pile holes will be pre-drilled and either a steel pile or a concrete pile used. This would still require a lesser amount of water than mass concrete foundations.

Sedibeng Water, a registered Water Services Provider has been approached and have indicated that they can provide the water required for the construction phase. The details of the supply point and conditions of supply will be investigated and resolved during the planning process.

WATER USAGE DURING OPERATIONAL PHASE

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

The water needed for cleaning is less than a litre per PV module per annum and less than 1 000lt per day will be needed for domestic purposes by the personnel on site. Thus for a 75MW PV plant about 1260kl is required per annum.

Sedibeng Water have indicated that they can also provide the water required for the operational phase.

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 have been defined for construction purposes and are indicated on the concept Site Development Plan:

- 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 to finish the process (wiring connection, gear mounting… etc).

SPOIL HEAPS AND BORROW PIT AREA

Borrow pit areas should not be needed because of the nature of the terrain and the expected type of road and structure foundations.

Only a small amount of gravel is needed for concrete production of cross-road-trenches, building foundations or concentrator box bases. This gravel can be obtained from commercial sources in the area and transported by truck to the sites.

Given that there is no significant earthworks in the construction process the only spoil envisaged would be material unsuitable to be used as backfilling that comes from the trenches or pile holes. This should be relatively insignificant volumes and can be spread on site. Should the volume be larger; then landscape features such as screening berms around the sub-station and PV plant can be created from the spoil. These would be covered with topsoil 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. Should the preferred option of vibratory driven piles be adopted then the construction traffic would be greatly reduced as there is little concrete required.

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
- Cleaning of PV modules
- 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.

DECOMMISSIONING OR UPGRADING PHASE

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

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 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 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 than those during site development and construction.