

# Khoi-Sun Development

October 18

# 2012

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Engineering overview and summary pertaining to environmental aspects of the  
Khoi-Sun Development. Compiled by Solek (Renewable Energy Engineers)

EIA Engineering  
Report

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## Abbreviations and Acronyms

• DAFF	Department of Agriculture, Forestry and Fisheries
• DEA	National Department of Environmental Affairs
• DWA	Department of Water Affairs
• EAP	Environmental Assessment Practitioner
• EIA	Environmental Impact Assessment
• EMP	Environmental Management Plan
• IPP	Independent Power Producer
• IPPPP	Independent Power Producer Procurement Program
• PPA	Power Purchase Agreement
• NEMA	National Environmental Management Act
• NERSA	National Energy Regulator of South Africa
• PV	Photo Voltaic
• ROD	Record of Decision
• SID	Strategically Important Development
• SANRAL	South African National Roads Agency Limited
• UNFCCC	United Nations Framework Convention on Climate Change

## 1. Introduction

Khoi-Sun Development (Pty) Ltd) as an Independent Power Producer (IPP) is proposing the establishment of a commercial solar energy facility on a site within the Northern Cape to be known as Khoi-Sun Development, with a power production capacity of 75MW. The Northern Cape is generally known to be one of the best preferred areas for the generation of solar energy in South Africa and even in the world due to abundant solar radiation. The purpose of this facility is to generate electricity from a renewable energy source (i.e. solar radiation) to provide power to the national electricity grid. The proposed development site is located within the Khai-Garib Municipality district approximately 100km North West of Kakamas, in the Northern Cape Province.

The purpose of this engineering report is to describe the various sections of the facility and provide a transparent view on facility operation and the possible effects on the environment. Solek, a renewable energy engineering company, is primarily responsible for the compilation of this section of the report, and a complete company profile is attached in the appendix for the readers convenience.

The report gives background on the energy market in South Africa and the opportunity for solar energy in the Northern Cape. The overall project and proposed facility is also described in more detail by investigating:

- The basic understanding of solar PV plants
- The description of the proposed solar facility
- The different steps in the construction phase of the proposed facility
- The project operation and maintenance phase
- Financial implications and financial overview (Cost Implications)
- Planned project timelines
- Overall conclusion

### 1.1. Background of the energy market in South Africa

The development of renewable energy in South Africa is gaining momentum at a significant pace, due to the incentives allocated towards approved projects by the South African government. Eskom's shortfall in its energy providing capability resulted in the development and construction of Medupi and Kusile coal power stations. Development of these power stations relied heavily on World Bank financial assistance. The loan requirements forced South Africa into the development of a renewable energy program, hence bringing to life the Independent Power Producer Procurement Program (IPPPP).

According to the Integrated Resource Plan 2010 (IRP 2010), South Africa will require 42 500 MW of additional energy over the following 20 years in order to meet the requirements created by the growing economy. Approximately 20% of this additional energy is projected to be supplied by solar power.

In order to stimulate the demand in solar power, the South African government has made 1450 MW of solar photovoltaic capacity available, which can be applied for by means of the Independent Power Producer Procurement Programme. The Department of Energy (DoE) has set, and postponed, five dates apart for the submission of bid documents for private companies to apply for a license to generate electricity. The deadlines for these five stages are as follows:

- 1<sup>st</sup> Bid Submission: 4 November 2011

- 2<sup>nd</sup> Bid Submission: 5 March 2012
- 3<sup>rd</sup> Bid Submission: 7 May 2013 (previously 20 August 2012)
- 4<sup>th</sup> Bid Submission: *to be confirmed* (previously 4 March 2013)
- 5<sup>th</sup> Bid Submission: *to be confirmed* (previously 13 August 2013)

Another market arising is that of green builders and corporate organisations which are to invest in green electricity and carbon emission reduction. This means that green electricity suppliers such as biogas or solar, will be bought at a premium price from private power producers and obtain a green status according to the United Nations Framework Convention on Climate Change (UNFCCC).

Large international companies seek opportunities in the local market. However, they lack experience with local authorities, procedures and political environment. This local 'know how' is favourable for South African companies and presents many more partnering opportunities with international companies.

### 1.2.Opportunity for solar energy in the Northern Cape

When considering South Africa's irradiation distribution, the Northern Cape Province is known to be one of the best preferred areas for the generation of solar energy in South Africa and even in the world. This can be ascribed to the advantageous sun radiation specifications and the vast flat planes that the province has to offer, which is not intensively used with the exception of farming. The global irradiation in the specific area is between 2400 and 2600 kWh/m<sup>2</sup>. Furthermore, specific parts of the Northern Cape can be used for the generation of power without compromising on food security due to the area's low food produce capacity per hectare of usable land. Below is a map which gives an overview of this power producing potential.

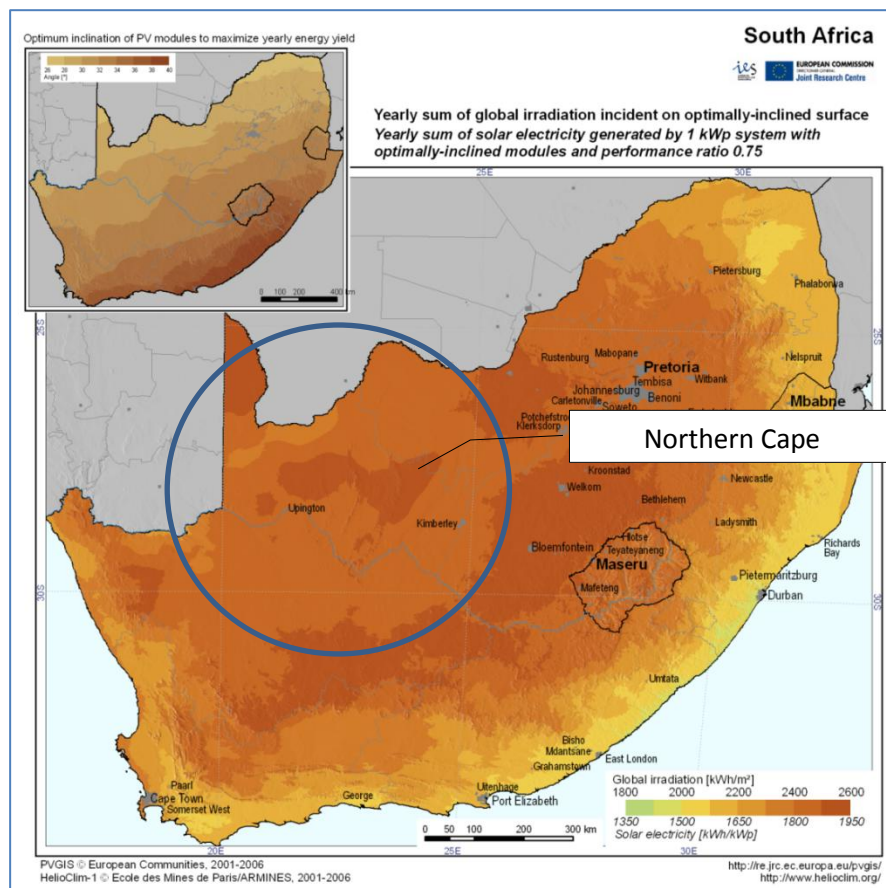


Figure 1: South African solar irradiation distribution

The benefits that the production of energy from the sun holds within the broader South African context outweighs most potential negative impacts the development may have on the bio-physical environment of the property. The contribution and agricultural value of the specific farm should be compared to the impact the national energy crisis could have. This crisis effects job creation, skills development, manufacturing, mining and economic growth potential of the renewable industry.

On the economic front, the proposed project has the potential of making a significantly positive contribution to the local economy. The Northern Cape was well-known for the large number of copper and zinc mines in the area, but since the early 1990's, many of these mines have closed down, leaving a devastating trail of unemployment behind. The local economy, mainly supported by farming, simply isn't enough to accommodate the high level of unemployment. In addition, poverty imposed social problems pose a problem in the surrounding area. The proposed development has the opportunity to create a significant amount of career opportunities over its entire lifespan of 20-30 years.

### **1.3.Overview of the proposed project**

The applicant is proposing the establishment of a commercial solar energy facility, known as the Khoi-Sun Development and will be operated under the licensed of a company bearing the same name, Khoi-Sun Development (Pty) Ltd. The proposed development site is located on Farm 426, Skuitdrift, approximately 100km northwest of the town Kakamas which is situated within the jurisdiction of the Khai-Garib Local Municipality in the Northern Cape Province. The purpose of the facility is to assist the government in providing much needed electricity by generating energy from a renewable energy source – the sun.

The proposed facility is to be designed for the generation of approximately 75MW of electricity, which will be fed into the national electricity grid. The proposed development site covers an area of around 250 hectares. The identified development site is located on the farm which covers 9800ha area in total. The area is located directly adjacent to the west of the existing Schuitdrift 132/33kV Eskom substation, which is situated on the same farm.

## **2. Solar energy as a power generation technology**

### **2.1.Basic understanding of solar PV plants**

Photovoltaic (PV) panels convert the energy delivered by the sun to direct current (DC) electric energy. The array of panels is connected to an inverter by means of a network of cables. The grid-tie-inverter, inverts the DC power to alternating current (AC) power which can be transferred to the national electricity network (grid). The voltage at which power is generated is stepped up to the required voltage and frequency of the national grid, by using transformers and specified inverters. The electricity is distributed from the onsite transformers via distribution lines to the adjacent Eskom Substation. From the Eskom substation, the electricity is fed into the national electricity network (grid).

The proposed Solar PV tracking technology is known as horizontal trackers. Horizontal trackers are ground-mounted and follow the sun's path with the use of typically single-axis technology in order to maximise the amount of direct sunlight on the Solar PV panels.



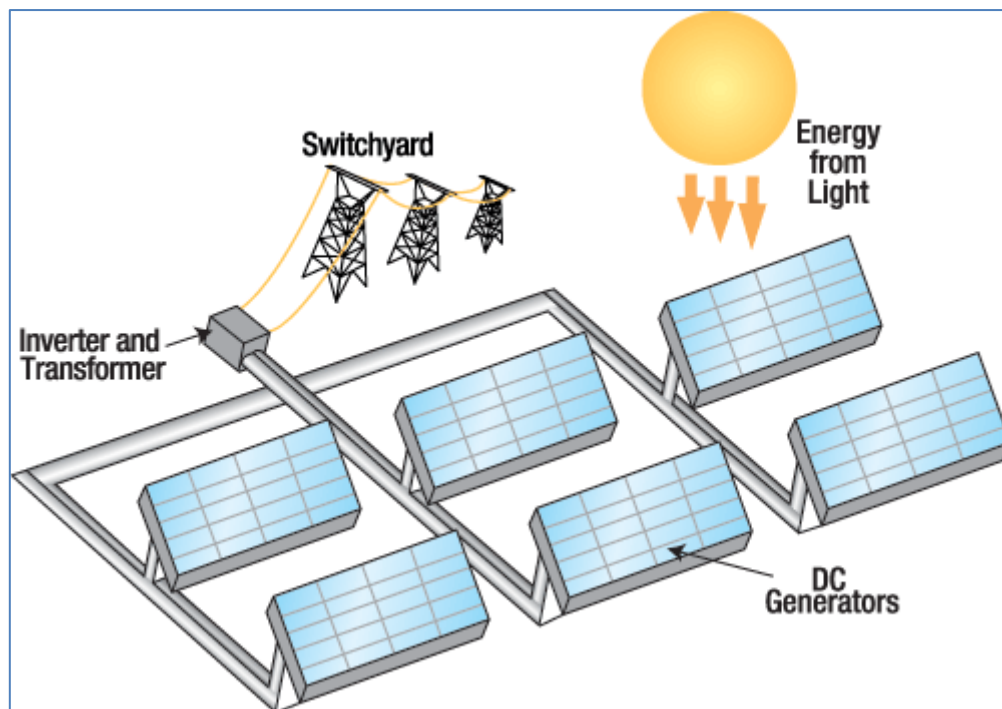


Figure 2: Typical Solar PV Plant diagram

The infrastructure of the facility includes the ground-mounted panels, cables, access roads, auxiliary roads, an onsite substation and a distribution line to the adjacent sub-station.

The primary input of the system is sunlight, which is converted to electricity. The facility also utilises auxiliary electricity from the Eskom grid to power tracker motors in order to optimise the amount of direct sunlight on the solar PV infrastructure.

## 2.2 Project related benefits

The single largest benefit of the generation of solar energy is the fact that the electricity is generated by means of a renewable source, the sun. This means that the project is sustainable and environmentally friendly and in essence the energy source cannot become depleted like fossil fuels, i.e. coal or oil. This type of energy production does not pollute the environment, it is renewable, reliable and it does not consume anything close to the amount of natural resources when compared to conventional power generation (e.g. coal power plants). Its long term environmental benefits are perhaps the most notable of any electricity source and holds much promise for reducing environmental impacts from electricity production from coal power plants – which is the most technology used in South Africa.

The production of 75MW's alternative energy is a welcomed supplement to South Africa's electricity supply and aligns with the government's targets of reducing reliance on fossil fuel based electricity. The renewable energy projects are treated as "Strategically Important Developments" (SID's) under the IPP Procurement Programmes, since these projects have the potential to make a significant contribution to the national and local economy.

Not only will the project contribute to the existing electricity Eskom grid in the area, but also in achieving the 40% share of new power generation being derived from IPP's nationally.

Long term benefits, particularly related to the local community and society, can be realised through the project, mainly in terms of much needed employment and skills development. Such a project is a very good stimulus for the local and national economy, positively contributing especially to the surrounding community. In addition, the general requirements provided for by government stipulate strong local procurements and local investments into the surrounding communities.

### 3. Description of the proposed solar facility

The proposed infrastructure, planned to be constructed includes a series of Solar PV arrays with inverters, internal electrical reticulation and an internal road network. It will also be necessary to construct an onsite substation which will typically include a transformer to allow the generated power to be connected to Eskom's electricity grid. Auxiliary buildings, including ablution, workshops and storage areas, are planned to be erected and a distribution line will also be required to distribute the generated electricity from the site to the existing Schuitdrift Eskom substation.

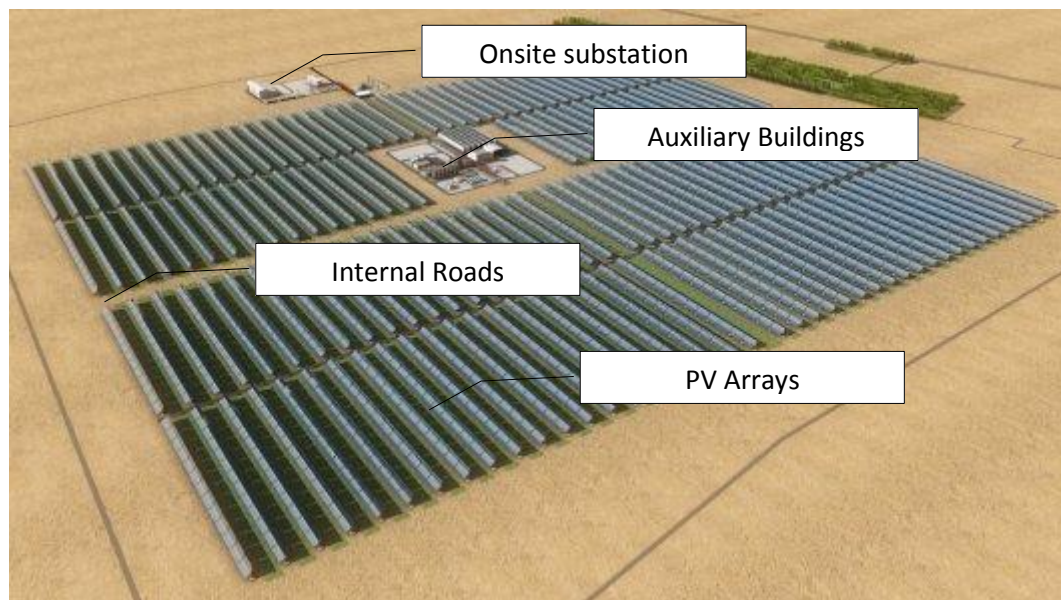


Figure 3: A typical layout of a Solar PV plant

The estimated portion of land each component will typically occupy is summarised in the table below:

Component	Estimate extent of the 75MW plant	Percentage of selected area (less than 250ha)	Percentage of whole farm (±9800ha)
<b>PV Arrays</b>	230 ha (2 km <sup>2</sup> )	90%	less than 2.5%
<b>Internal Roads</b>	12 ha (0.12 km <sup>2</sup> )	6%	less than 0.2%
<b>Auxiliary Building Area</b>	1 ha ( 0.01 km <sup>2</sup> )	0.5%	less than 0.02%

#### 3.1. Site development components

The final design will consist of different components. A typical description of the components and their assumed impact are listed below:

### 1. *Position of solar facilities*

The exact position of the solar PV array layout will be determined by the recommendations from the environmental specialists' reports to avoid all sensitive areas in the positioning of the facility. In addition the final layout will be influenced by the final detail design of the project once a tender has been awarded. The layout will be located on around 250ha of the proposed site (Farm 426).



Figure 4: Typical layout of solar arrays

### 2. *Foundation footprint*

The physical footprint of the PV panels on the ground is formed by a network of vertical poles (typically 100mm in diameter), on which the PV panels are to be mounted (see examples below).



Figure 5: Foundation footprint

Basic drilling or hammering techniques using special tools is used known as ramming. Removal of such foundations is possible upon de-commissioning of the project. The use of concrete for stabilisation is to be avoided as far as possible.

### 3. *Construction period laydown area*

The laydown area will typically be used for assembly of the PV panels and as a general placement/storage section for construction equipment. The laydown area for the construction period will be approximately 1ha and will be determined by the recommendations from the environmental specialists' reports to avoid all sensitive areas in the positioning of the facility.



#### 4. *Internal roads indication width*

Gravelled internal roads and un-surfaced access tracks are to be provided for. Such access tracks (<4m width and limited to the construction site) will form part of the development footprint. Pathways (<4m width) between the PV panel layout will typically also be provided for cleaning and maintenance of the panels. Existing roads and tracks will be used as far as possible.



#### 5. *Onsite substations and transformers*

The step-up substation and its associated infrastructure and internal roads should have a footprint of approximately 0.04 ha (20mx20m). Note that the 0.04 ha is included in the entire building footprint of <1ha.



Figure 7: Typical onsite substation footprint

#### 6. *Cable routes and trench dimensions*

Shallow trenches for electric cables will be required to connect the PV Panels to the onsite substation (such electric cables are planned along internal roads and/or along pathways between the PV panels).



Figure 8: Cable trenches

### **7. Connection routes to the distribution/ transmission network**

Electricity will be transmitted from the onsite step-up substation via new overhead power lines to the existing Eskom substation which is located adjacent and West of the proposed site.

### **8. Cut and fill areas**

As far as possible, any cut and fill activity along the access roads will be avoided. The existing roads are currently being used by construction vehicles and should not need any alternation.

### **9. Borrow pits**

As far as possible, the creation of borrow pits will also be avoided. Where possible, road surfacing material required (e.g. gravel/base course or stone) will be trucked in to the site from licensed outside sources if required. Currently no borrow pits is planned for this construction site.

### **10. Soil heaps**

As far as possible, the creation of permanent soil heaps will be avoided. All topsoil removed for the purpose of digging foundations are to be separately stockpiled within the boundaries of the specified development footprint, for later rehabilitation. It is unlikely that major soil heaps will be required for this construction site.

### **11. Auxiliary buildings**

The Auxiliary buildings area will typically include:

- A Workshop
- A Storeroom
- A Change and ablution room
- An administrative and security building
- 10x 10kL water tanks



**Figure 9: Foundation of a typical onsite building**

The infrastructure boundaries for the auxiliary buildings should occupy approximately 1ha. The workshop will be used for general maintenance of parts, etc. and will typically be 20mx20m. The storeroom will be used for storage of small equipment and parts and will typically be 10mx10m. The change and ablution facilities will be very basic and include toilets, basins and a change area. The administrative and security building will be used as an onsite office and will have a footprint of typically 20mx10m.

The final detailed design and exact coordinated layout of the facility will be designed and finalised should the facility be approved and awarded a tender as an IPP. The component list above is typical to such projects and may deviate due to engineering requirements, new technologies and regulatory changes from the government's tender process. This will be done should the project be approved and the environmental specialists recommendations have been made.

## **3.2. Project alternatives**

In order to propose the best possible design in terms of economic aspects, several alternatives have been considered. The various alternatives considered in terms of site, layout, technology and distribution lines are discussed in the following sections.

### 3.2.1. Layout Alternatives

The actual location of the different facility components on the less than 250ha development site may vary. Determining the optimal layout is a costly process which would normally take place once an IPP tender has been awarded to the bidder. Several Solar PV array layout alternatives have however been considered (see Layout Report) and a preferred layout have been identified taking into account the site constraints identified and recommendations made by the various EIA specialists. With the actual construction, the preferred plant layout will stay the same in terms of footprint and size, but the exact location may change within the 265ha boundary.

### 3.2.2. Technology Alternatives

Photovoltaic (PV) solar power technology has been identified as the preferred technology to generate electricity in this project. There are however, several alternate options in terms of the specific Solar PV technology to be used. These alternatives can be grouped in terms of mounting and film alternatives but should not trigger any major difference in the impact of the project as explained in this report.

#### *Mounting Alternatives*

There are two major alternatives in terms of Solar PV mounting, namely fixed-tilt and tracker mounting technology.

When fixed-tilt solar mounting technology is considered, the Solar PV modules are fixed to the ground and do not contain any moving parts. These modules are fixed at a specific north facing angle. This type of technology is less expensive option than tracker technology, but it has a lower energy yield due to the limited exposure to sun radiation.

The preferred technology type is known as horizontal tracker technology. This single-axis technology is designed to follow the path of the sun across the sky. By using to this technology, the modules are exposed to typically 25% more radiation than fixed systems. The design is extremely robust and contains only a few moving parts still having more or less the same footprint and infrastructure requirements than that of fixed-tilt designs.



Figure 10: PV tracker mountings

The foundation of mountings can either be laid in concrete, driven piers or screws. Driven piers and screws are recommended in order to minimise the environmental impact of the facility. This technology imposes a lower cost over the lifetime of the project and offers higher equity returns for investors. The operational risks are limited due to the proven performance and track record.

The tracker requires approximately 1.8 to 2.3 hectares per megawatt. The tracking design is based on a simple design and makes use of a well proven off-the-shelve technology which is readily available. The maximum height of the trackers is typically less than 2m.

### **Film Alternatives**

There are a multitude of different film technologies available today. The best solution, according to research conducted are currently either thin film (amorphous silicon or cadmium telluride) or multi-crystalline cells depending on the space and irradiance conditions, with the electricity yield and application being the deciding factor.

Multi-crystalline cells are the preferred technology type in South Africa, since the output of this technology is higher and it performs better under higher temperatures than the thin film technology. Furthermore, thin film technology is not yet feasible for South African large scale projects due to its higher price.

As mentioned earlier, the film type do not affect the layout and impact from an environmental perspective and would not affect the environmental impact of the proposed project.

#### **3.2.3. The “do-nothing” Alternative**

Farm 426 Skuitdrift is currently used for limited stock grazing, limited by water availability and arid weather conditions. The exclusion of 250ha from the 9800ha property for the purposes of the solar facility will not have a significant effect on these farming activities, and minimal impact on the agricultural resources (soil and water). Should the do-nothing alternative be considered, the positive impacts associated with the solar facility (increased revenue for the farmer, local employment and generation of electricity from a renewable resource) will not be realised.

*Cape EAPrac*, the project’s environmental assessment practitioners, will report on a full investigation on what environmental impact the option of not developing the proposed facility will have.

## **4. Construction of the proposed facility**

The construction phase of the solar facility should be between 16-18 months. The construction phase of the facility will create roughly 40-50 employment opportunities (during construction) of which most will ideally be local employments. The construction material and sourcing of required goods would most probably be from the local community and surrounding towns.

Should the project be approved, and all required approvals and licenses are obtained from the DEA, NERSA and a Power Purchase Agreement (PPA) is secured with Eskom (Single Buyer’s Office, in collaboration with Department of Energy, under IPPPP), the construction is envisioned to begin in the second half of 2014. A series of activities would need to be undertaken, to construct the proposed facility and associated infrastructure.

The facility will be established in different phases namely: the pre-construction, construction, operation and decommissioning phases.

The **preconstruction phase** includes:

1. Conducting of surveys;
2. Transporting of the required construction components and equipment to site.
3. Pre-site preparation (establishment of temporary services for construction such as lavatories, water, health & safety requirements, site office etc.)



The **construction phase** includes:

1. Transportation of solar components and equipment to site,
2. Establishment of internal access roads,
3. Undertaking site preparation ( i.e. including clearance of vegetation; and stripping of topsoil where necessary),
4. Erecting of solar PV frames and panels,
5. Constructing the onsite substation,
6. Establishment of additional infrastructure (workshop and maintenance buildings),
7. Establishing the underground connections between PV panels and onsite substation
8. Connection of onsite substation to power grid
9. Undertaking site remediation

The activities that will be undertaken on site, fall under different specialist fields, and include:

- **Civil works:** Site Preparation, Site grading, Drainage, Roads, Foundations, Stormwater & Anti-erosion Management
- **Mechanical works :** Piers Installations, Mechanical Assembly including trackers, Mounting of Panels
- **Electrical works :** Installation from low to high voltage including substation

For the purpose of the engineering report, the stages of the construction phase that have engineering implications will be discussed.

#### **4.1. Transportation of solar components and equipment to site**

All solar plant components and equipment are to be transported to the planned site by road. Construction should stretch over a period of approximately 18 months. During this period the majority of the solar PV panels and construction components will be transported by utilising 2x40ft container trucks.

Less than 30 containers will be required per megawatt installed. This will typically include all solar PV components and additional construction equipment. Over the period of 18 months, 2250 containers will therefore be transported to the proposed site. Roughly estimated this amounts to two 2x40ft container trucks per day. Normal construction traffic will also need to be taken into account. The usual civil engineering construction equipment will need to be transported to the site (e.g. excavators, trucks, graders, compaction equipment, cement trucks, etc.) as well as components required for the establishment of the onsite substation power line. Some of this power station equipment may be defined as abnormal loads in terms of the Road Traffic Act (Act No.29 of 1989). Input and approval are to be sought from the relevant road authorities for this purpose.

Transport to the site will be along appropriate national, provincial and local roads. The access roads to the site will be from Pofadder or Kakamas, along the N14. This is a tarred national road and no alterations should be necessary to handle construction traffic and traffic involved in the operation phase. The access road to the Skuitdrift facility from the N14 has been confirmed as two divisional roads, the R359 and DR3256 which falls under the Siyanda District Municipality. After a very extensive process it has been clarified that this should not pose any constraints to the projects.



According to SANRAL (the South African National Road Agency Limited) these roads fall under Department of Transport, Northern Cape, and no private farm owners consent is necessary.

In some instances, the smaller farm roads may require some alterations (e.g. widening of corners etc.), due to the dimensional requirements of the loads to be transported during the construction phase (i.e. transformers of the onsite substation). Permission from the local authorities can be obtained in this regard if required.

#### 4.2. Establishment of internal access roads on the farm

Internal maintenance roads on the farm and proposed construction site are to be constructed. Where necessary, gravel may be used to service sections of the existing road on the farm itself.

The construction of the access road would normally consist of compacted rock-fill with a layer of higher quality surfacing stone on top. The proposed internal farm access roads will either be comprised of gravel tracks or of compacted rock-fill with layer of higher quality surface stone on top. The preferred alternative is still to be confirmed. If compacted rock-fill is used, a geotechnical survey is planned to be completed to assess the strength and durability properties of the rock strata at the site. It might be necessary to strip off some of the existing vegetation and level the exposed ground surface, in order to form an access track surface. Such access tracks (less than 4m width) will form part of the less than 20ha development footprint. The layout and alignment of these internal roads will be informed by recommendations made by the botanical specialist, as well as the topographical survey. Pathways (less than 4m width) between the Solar PV panels are to be provided for ease of maintenance and cleaning of the panels.

#### 4.3. Site preparation

Cleaning of the surface areas is necessary in order to construct the solar PV plant. This will include clearance of vegetation at the footprint of the solar PV panels, the digging of the onsite substation and workshop area foundations and the establishment of the internal access roads and laydown areas. Where possible vegetation will be trimmed and not removed. Where stripping of the topsoil is required, the soil is planned to either be stockpiled, backfilled and or spread on site.



Figure 11: Illustration of a typical site after preparation

To reduce the risk of open ground erosion, the site preparation will typically be undertaken in a systematic manner. Where any floral species of concern or sites of cultural / heritage value are involved, measures are to be put in place to attend to the preservation or restoration of these elements.

#### 4.4.Erecting of solar PV panels



Figure 12: Onsite construction of the PV arrays

Once the site preparation has been done, and all necessary equipment has been transported to the site, the Solar PV panels and structures are assembled on site. Each Solar PV module consist of 60 monocrystalline silicon cells , forming a single panel. Each module is capable of generating typically 230W of DC electrical power. The solar PV modules are assembled in long rows across the Solar PV array, with the rows approximately 5m apart. The exact amount of modules in each Solar PV array is subject to the final facility design and is still to be confirmed. Foundation holes for the Solar PV panels are to be mechanically quarried to a depth of approximately 30-50cm. Driven piers and screws are recommended in order to minimise the environmental impact of the facility, hence reduced reliance on concrete foundations.

#### 4.5.Construct onsite substation

An onsite substation will be necessary to enable the connection between the solar energy plant and the National Eskom electricity grid. The generated voltage is planned to be stepped up to 132kV by means of such an onsite substation in order to be fed into the Eskom grid via the Schuitdrift Eskom substation, shown below.



Figure 13: Schuitdrift Eskom substation

The onsite substation is constructed in a few sequential steps. First a site is determined by the recommendations from the environmental specialist's reports to avoid the most sensitive areas in the positioning of the substation. Once the site is approved, the site clearing and levelling is to be done, after which the access roads to the substation are constructed. Next the substation

foundation is laid. Once the foundation is constructed, the assembly, erection and installation of all equipment including the transformers are to be completed. The final step is the connection of the conductors to the equipment. The post-construction phase includes the rehabilitation of disturbed areas and protection of erosion sensitive areas. Below is typical onsite substation that connects to the existing Eskom substation.



Figure 14 : Typical onsite substation

#### 4.6. Establishment of additional infrastructure

To minimise the potential ecological impact a project of this scope, a decision was made to limit all activities and storage of equipment to one nominated area. A dedicated construction equipment camp and laydown area is planned to be established, which will later form part of the auxiliary building area. This area will typically be used for the assembly of the solar PV panels and the generation placement/ storage of construction equipment. A temporary facility are planned to be used to secure the storage of fuel for the on-site construction vehicles. Necessary control measures will be put in place for correct transfer and use of fuel.

The auxiliary building area will typically consist of the following:

- A Workshop
- A Storeroom
- A Change and Ablution room
- An Administrative and security building
- 10x 10kL water tanks

#### 4.7. Connect onsite substation to power grid

In order to evacuate the power generated by the proposed facility and feed it into the Eskom grid, a distribution line would have to be constructed between the proposed onsitesubstation and the existing Eskom substation. The proposed onsite substation is approximately 200m from the existing Eskom substation.

The Schuitdrift Eskom substation is currently fitted with a 10MVA 132/33kV step-down transformer and is fed from Paulputs with a 132kV line. From here the power is distributed via a 132kV line to Blouputs and 33kV lines towards Southern Farms, Raap&Skraap and Pofadder.

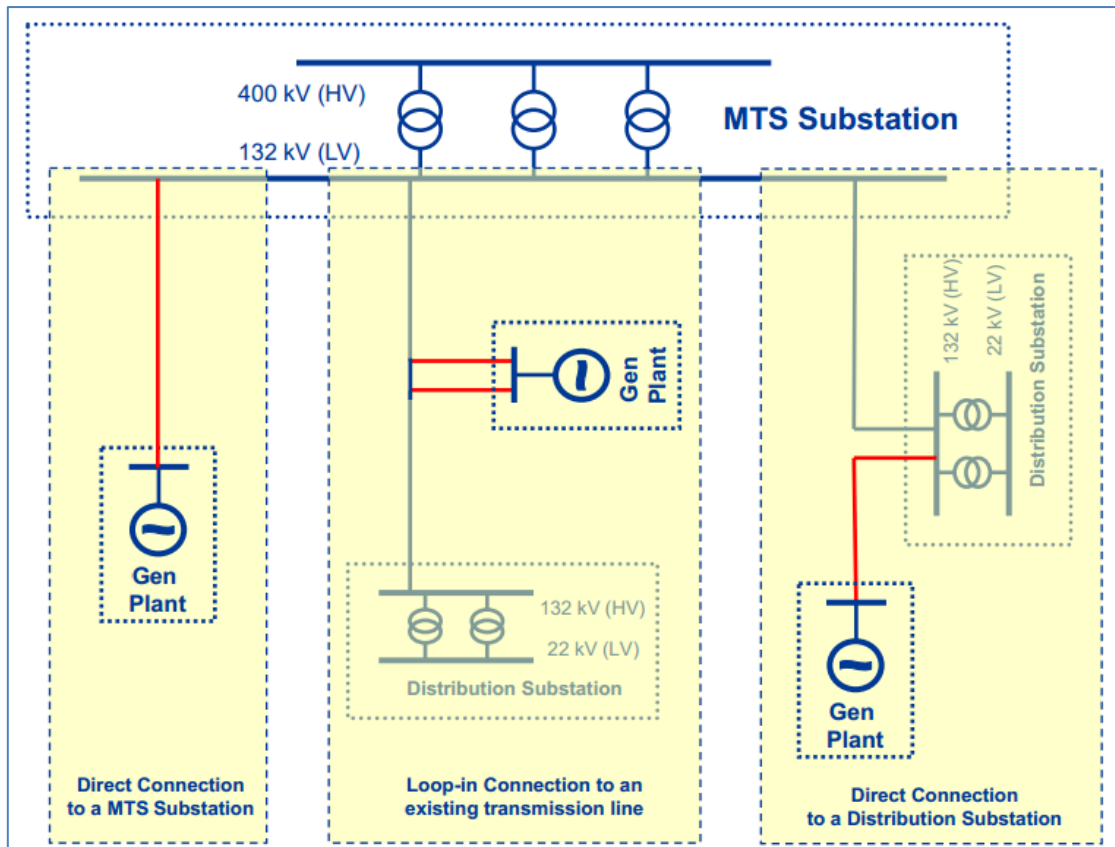


Figure 15: The different connection alternatives

There is currently an excess capacity of 75MW available at the Schuitdrift Eskom substation when connecting to the 132kV busbar or 10MW when connecting to the 33kV busbar without any alterations of the substation's existing infrastructure necessary. It is proposed to construct a 132kV distribution line between the site and the existing Eskom substation. This line will be constructed by the developers, but would be handed over to Eskom for operation and maintenance.

Skuitdrift is supplied from Paulputs substation, which is equipped with a 125MVA 220/132kV transformer. Currently 110MW has been allocated to the IPPPP phase 1 preferred bidders. Depending on the allocation of preferred bidders in IPPPP phase 2, Paulputs might require strengthening to accommodate additional generation which might require a second transformer being installed.

The single largest risk involved in terms of grid connection is the timelines involved in the upgrading of the Eskom substation if necessary. If the capacity of the substation is allocated to other preferred bidders after IPPPP phase 3, the substation should be upgraded, which could influence the timelines of the project significantly. The upgrade of the substation will also impose significant financial implications.

Feedback from Eskom on the Draft Engineering Report and Draft Scoping Report provides guidance with regard to the planned development, which has been considered during the layout planning. Eskom also provided generic requirements for works at or near Eskom infrastructure. Eskom's recommendations will be taken into account and a declaration letter explaining the process followed has been attached.

#### **4.8.Undertake site remediation**

Once construction is completed and once all construction equipment is removed, the site is to be rehabilitated where practical and reasonable. In the occurrence where access routes to the site were used which will not be used during operation, the access points are to be closed and rehabilitated.

### **5. Establishment of water sources**

It is estimated that approximately 11 200 kl of water in total should be required during the 18 month construction phase (with is an average of 24kl per day when construction is calculated at 6 days a week). In addition, 10 - 18kl of water per day should be required for the cleaning of solar panels and for other operational phase requirements. Note that in terms of cooling of the electricity transformers, dry cooling is to be implemented by means of resin cast transformers.

Weather conditions, traffic and general dustiness of the site play a role in the exact amount of ground water required to wash the Solar PV panels. At present it is assumed that each panel should be washed twice a month.

To further reduce the use of water at the solar facility, the use of alternative panel cleaning methods is also being investigated. The most feasible technology under consideration uses compressed air to blow off any debris from the panel's surface. At this stage the technology is being tested and needs refinement before it would be commercially viable.

#### **5.1.Water sources**

##### **1. Boreholes:**

The preferred water sources are the existing nearby boreholes on the proposed farm. Three boreholes are situated near the proposed site, and are seen as water options for the facility. The small volumes of water required for washing of the Solar PV panels and for general operational purposes (maximum of 18kl per day or 500kl per month) can be sourced from this borehole. According to the initial drilling test records, the boreholes are all strong enough and the water it supplies is drinking water quality. The boreholes at the proposed site can currently supply over 130kl per day compared to the 18kl required. The borehole statistics is attached for the reader's convenience.

##### **2. Southern Farms (alternative supply)**

Another option is to get water from Southern Farms, which is situated 7km directly north of the proposed site. Southern Farms acquires water from the Orange River. Negotiations regarding this agreement are being done with the Southern Farms Management. In principle Southern Farms does not have any objections supplying the water, as long as the requirements from the DWA are adhered to. A formal letter confirming the consent has been received. In the instance of the onsite bore-holes not being approved as a liable water source, a pipeline would then be aligned from the proposed site to the Southern Farms facilities, along an existing road. The screening of this road has been included in the specialists' studies. If this option is taken, the water use license application will become an integrated water use license application where Section 21 C and I will also be included as required by the DWA.



### 3. Rainwater

As an additional measure, PVC rainwater tanks could also be placed alongside the onsite buildings to collect the rainwater runoff from the roof. These PVC tanks will then form part of the water storing tanks. If necessary, measures can also be put in place to capture the rainwater runoff from the PV panels.

#### 5.2. Water buffer

Water storing infrastructure is to be provided as part of the auxiliary building footprint area. A week's storing capacity are planned to be provided for. This will add up to 10 x 10 kl water tanks.



Figure 16: Typical water storage tank

#### 5.3. Water-use permission

The quantity of water required usually qualifies for a general authorisation, but the specific quaternary area in which the development site is situated does not allow for general authorisation. Thus, a formal water use license would have to be applied for. However, after various discussions with the DWA, it was confirmed that a full assessment of the water use license application will only be undertaken by the DWA, once DEA and DAFF have issued the ROD and the proposed project has been appointed as a preferred bidder by the Department of Energy (DOE). The EIA application can therefore be submitted without a water licence, as long as there is enough confirmation that there are sufficient water available. Feedback from the DWA on the Draft Engineering Report and Draft Scoping Report provides guidance on the requirements for the Water Use Licence and associated water use monitoring. The recommendations made by the DWA will be taken into account. A water declaration letter explaining the process followed has been attached.

#### 5.4. Erosion and storm water control

Due to the extremely low annual rainfall the risk of water erosion is low. The ground condition in the Skuitdrift area is such that any surface water is very quickly absorbed into the soil which avoids water build up on the surface and quickly reducing any water flow which might cause water erosion.

On large structures or buildings appropriate guttering would be used around the building to avoid water erosion where roof water would be flowing off the roof. Wherever practically possible rainfall run-off from the roofs/ gutters will be captured and stored in rainwater tanks. If this water cannot

be captured water will be channelled into energy dissipating structures to spread the water and slowing it down to reduce the risk of erosion. Such a structure could be moulded from precast concrete, loosely packed rock or perforated bags filled with stone.

Any rainfall on the solar panels would be welcomed due to its cleaning effect, but as mentioned before the annual predicted rainfall is very low and would not cause any erosion worth discussing. The solar panel surfaces are installed at a relatively large incline with gaps between panels. This does not allow significant water build up on the panels while also reducing the energy in falling droplets. Considering that the panels are on a tracking system, this also means that droplets leaving the solar panel surface would not drop onto the same ground areas all this time.

The construction area would cross over a number of seasonal washes. To avoid erosion in these washes recognised building practices will be followed to keep the natural flow of water within its natural borders. It is in the interest of the solar operator to keep the area clean and free of erosion to avoid any damage to the equipment. The solar panels would be installed on frames, allowing for natural water flow underneath the structure.

During the construction phase of the project there might be a risk of wind erosion where natural vegetation is removed. This might increase the risk of damaging sensitive equipment with a sandblasting effect and all parties involved will be vigilant to avoiding this from happening. Once the construction phase is complete the cleared areas will be re-vegetated with locally-collected seed of indigenous species and left for vegetation to return to the area naturally. Bare areas will also be packed with brush removed from other parts of the site to encourage natural vegetation regeneration and limit erosion. Any water being used in the cleaning process would speed up this natural vegetation rehabilitation process. Further it will also have a bonding effect on the sandy soil, avoiding the loose sand blowing away causing wind erosion.



Figure 17: Illustration of current vegetation on the farm

Access roads and internal roads would also be designed and build using recognised erosion and storm water management systems. During the construction phase of the solar PV facility temporary solutions would be implemented to ensure that the environment is preserved in a sustainable way by avoiding erosion. The following figure shows a typical temporary solution that would be implemented during the construction phase, basically consisting of an inlet, channel and outlet. During outflow of the water energy is dissipated allowing any particles to sink to the ground which also avoids fast flowing water to sweep particles up from the ground avoiding erosion, by flowing through packed stones acting as a filter.



Figure 18: Installed concrete pipes and culverts

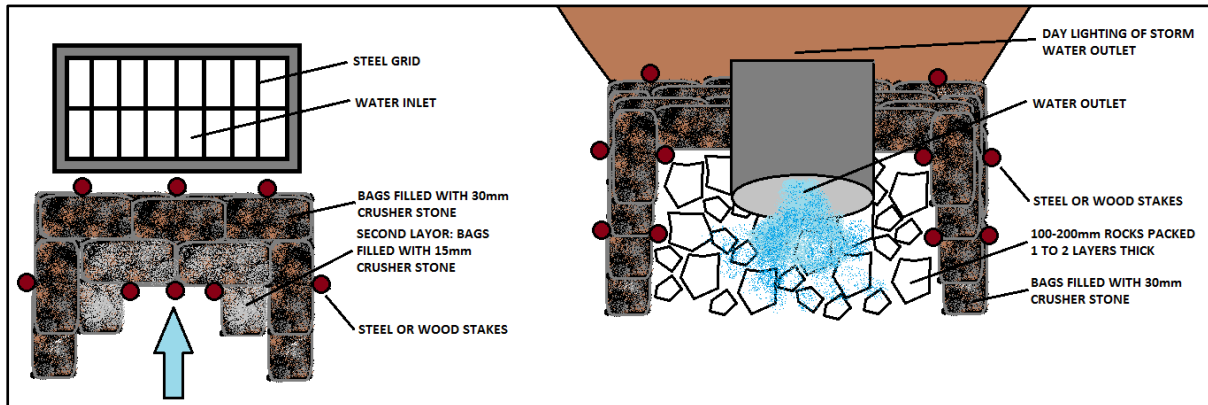


Figure 19: Temporary culvert inlet and outlet

More permanent solutions would be designed to keep storm water under control in a sustainable way. These structures would be built to be aesthetically pleasing by using fixtures such as stones packed in wire mesh to stay in a position or locking retaining walls at the inflow and outflow of the culverts also acting as scour protection. Depending on the situation which is influenced by the type of water control most probably being Stream crossing (in this particular case it would be a dry water wash for most of the year) or a culvert for water runoff management, either portal culverts with bases or reinforced precast concrete pipes would be used as the channelling.

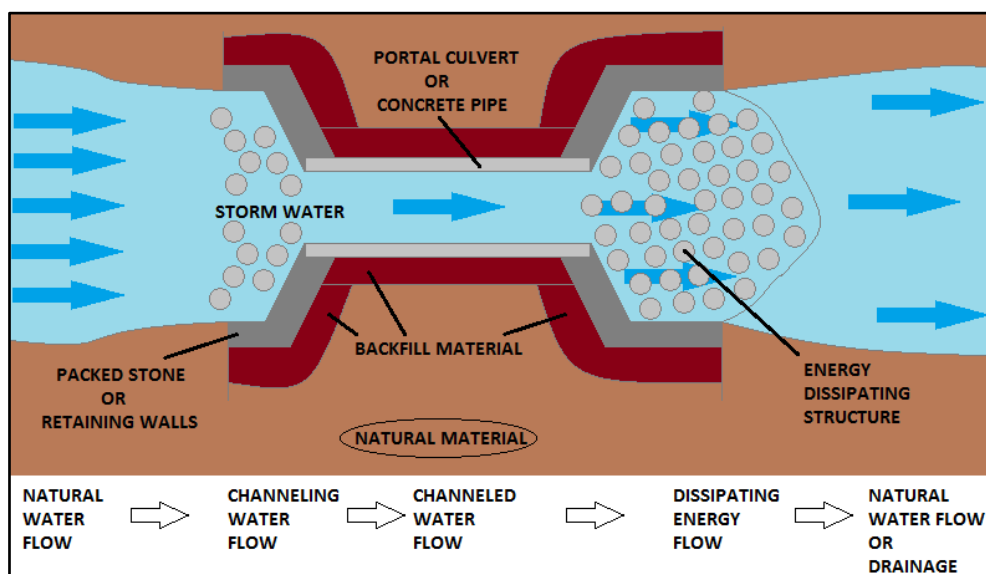


Figure 20: Storm water flow



An alternative to culverts considering drainage line crossings, Low-level River Crossings (LLRC) can be used. A LLRC is a structure that is designed in such a way to provide a bridge when water flow is low, while under high flow conditions water runs over the roadway, without causing damage.

Two types of LLRC can be used depending of the particular situation. A “Causeway” contains openings underneath the surface, which allows passing water through where a “Drift” does not.

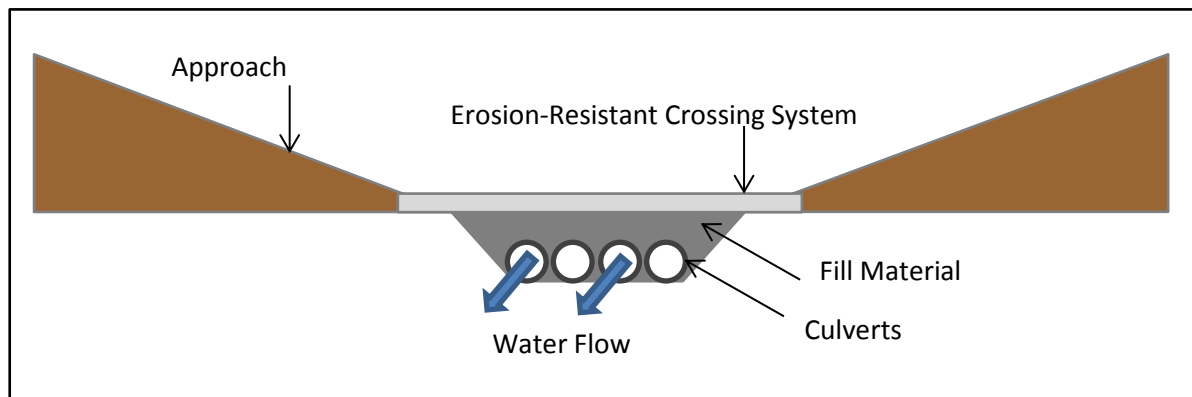


Figure 21: Causeway (Low Level River Crossing)

The same type of erosion control methods discussed with the culverts is taken into account when designing a LLRC. Because a LLRC is designed for water to flow over it, erosion protection is very important. Rock filled baskets, loosely packed rock or perforated bags filled with stone are some of the methods usually considered with LLRC.

## 6. Project operation and maintenance phase

The aim is to generate at full capacity by 2016. The facility should be operational during daylight hours, except during maintenance, poor weather conditions or breakdowns. Regular maintenance will typically include periodic cleaning, greasing of bearings and inspection. The panels are to be cleaned with water or compressed air, while any waste products are to be disposed of in accordance with relevant waste management legislation.

An estimated total of six full time staff members will typically be required during the operation phase of the project, which includes permanent technicians, maintenance and security personnel. Approximately three unskilled labourers will be needed for maintenance purposes and two security personnel will be deployed on a shift basis. One skilled staff member will be needed to manage and oversee the operations. Staff can be transported around the site using utility vehicles and a typical mini bus to transport staff from nearby towns of Kakamas and surrounding community. From time to time additional contract staff may be required for ad hoc ground cleaning or special panel cleaning.

## 7. Project decommission phase

The proposed solar energy facility is expected to have a lifespan of approximately 30 years if the specified periodic maintenance is performed. Once the facility has reached the end of its economic life, the infrastructure is to be decommissioned. The decommissioning of the facility would entail the disassembly and replacement of components with other appropriate technologies. However, if not

deemed so, then the facility would be completely decommissioned which would include the following decommissioning activities.

Site decommissioning preparation activities should include confirming the integrity of access to the site. Site access should be able to accommodate the required equipment (e.g. lay down areas, construction platform) and the mobilisation of decommissioning equipment.

The components would be disassembled, reused and recycled where possible, or disposed of in accordance with regulatory requirements. Functional components are planned to be donated to and installed at local schools and clinics for the benefit of the community.

## 8. Project output

### 8.1. Waste effluent, emission and noise management

#### *Solid waste management*

During the construction phase an estimated amount of less than 5m<sup>3</sup> non-hazardous solid construction waste are to be produced per month, for the expected 6 month construction period. All construction waste should be safely stored, and should be removed from site on an ad hoc basis by the appointed construction contractor where and when deemed necessary. The construction waste, where applicable, are to be disposed at an appropriately licenced Municipal landfill site.

During operational phase after construction, the facility should not produce any solid wastes.

#### *Liquid effluent (sewage)*

Sewage is planned to be treated onsite by means of a septic tank system or conservancy tank system. Due to the locality of the farm, sewage cannot be disposed in a municipal sewage system.

#### *Emissions into the atmosphere and noise generation*

Very little emissions should be released into the atmosphere and no significant noise should be generated, except during the construction period with drilling and hammering. Due to the site location this should not pose any issue as no residential area is located nearby.

## 9. Cost implications & revenue

### 9.1. Project cost overview

Renewable energy projects, such as the Khoi-Sun Development, require significant investment. Funds of equity and debt investors, either from foreign or domestic sources are obtained. The cost requirements and potential revenue is discussed in this section, sketching a business case for the development of renewable energy projects within South Africa (specifically solar farms in the Northern Cape).

The project costs consist of two parts, capital cost and running cost. The capital cost pertains to all costs incurred for the establishment of a producing facility. The running cost relates to those costs incurred to ensure that the facility operates as it should throughout its expected lifetime.

Solar PV installations can operate for many years with little maintenance or intervention. Therefore after the initial capital outlay required for building the solar power plant, financial investment is limited. Operating costs are also extremely low compared to existing power technologies.

### 9.2. Project specific costs

The Khoi-Sun Development's detail costing has not been completed on the date of submitting this engineering report. The project is however based on the industry standard cost, with capital expenditure that can amount to more or less R30M per megawatt installed capacity. The running cost of a Solar PV facility is minimal related to the initial capital cost, contributing to the most significant cost of constructing and running a solar PV facility.

### 9.3. Revenue streams

The payback of the Khoi-Sun Development results mainly from electricity sales, intended under the current governmental subsidy, known as the Independent Power Producer Procurement Program (IPP procurement program).

The IPP procurement program portrays fixed ceiling prices for bidders to tender against. The establishment of these ceiling prices is based on industry standard return on investments. The governmental study performed identified the feed-in tariff per technology related to the capital cost required per technology against its revenue potential, identifying the required subsidy per technology to be paid.

In short the subsidy offered by the governmental procurement program (IPP procurement program) enables the project to be financially viable by selling electricity at a subsidised price, while the costs of such a facility relates to the industry standard.

As part of the IPP procurement program preferred bidders will enter into a power purchase agreement between the IPP generator and the Single Buyers office. National treasury stands-in for surety, while NERSA regulates the IPP licences.

NERSA and the IPP procurement program require an approved EIA Environmental Authorisation / Record of Decision as a gate keeping criteria, where no project would be considered without the EIA Environmental Authorisation being given.

## 10. Project program and timelines

As mentioned previously the Khoi-Sun Development is intended to be lodged under the IPP procurement program. The program has definite and stringent timelines, which the project should meet:

#	Description	Timeline
1	IPP procurement program submission (3 <sup>rd</sup> round)	7 May 2013
2	Preferred bidders selected	21 July 2013
3	Finalisation of agreements	July 2013 – January 2014
4	Procurement of infrastructure	February 2014 – April 2014
5	Construction	May 2014 – October 2015
6	Commissioning	November 2015 – January 2016

The table above clearly depicts the dependence of the project on the IPP procurement program's timelines. Any delay within the IPP procurement program will have a corresponding effect on the timelines of the Khoi-Sun Development's timelines.

## **11. Conclusion**

In conclusion, the overall significance of the Khoi-Sun Development outweighs the negative impacts the project can have. From an environmental perspective the project can be well-managed with sound contingencies being put in place to prevent harm to surrounding areas.

The project does make significant contribution from a social and economic perspective. Such benefits include potential revenue for the landowner, job creation during construction and the 20-30 year operational phase. In addition, much needed electricity is generated and fed into Eskom's national grid, taken from a sustainable carbon-free natural energy resource.

If the recommended mitigation measures contained in the EMP are implemented, there should be no lasting significant negative environmental impacts arising from the development of the project. This pertains to the construction phase as well as the operational phase. Solar projects use remarkable technology which can ensure a sustainable future for electricity generation. This is especially true since it do not severely impact the environment as with coal power generation or similar technologies.

In the light of the long term benefits the Khoi-Sun Development has, upon approval of this application the project can be implemented with minimum environmental negatives.

## **Appendixes**

- I. Solek Company Profile**
- II. Water declaration - Skuitdrift**