GORDONIA SOLAR PV PTY LTD

TECHNICAL LAYOUT DEVELOPMENT REPORT FOR GORDONIA SOLAR PV

(PV Magazine, 2018)

Prepared for:

Cape Environmental Assessment Practitioners (Pty) Ltd

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1. INTRODUCTION

Gordonia Solar PV (Pty) Ltd is proposing the establishment of a commercial photovoltaic (PV) solar energy facility (SEF), called Gordonia PV, located on Geel Kop Farm 456 Remaining Extent which is located approximately 30 km south west of Upington and 16 km north east of Keimoes in the Kai!Garib Local Municipality (ZF Mgcawu District Municipality) in the Northern Cape, hereinafter referred to as the Site.

The technology under consideration is photovoltaic (PV) modules mounted on either fixed-tilt or tracking structures. Other infrastructure includes inverter stations, internal electrical reticulation, internal roads, an on-site switching station/substation, potentially a 132 kV overhead power line (OHL), auxiliary buildings, construction laydown areas and perimeter fencing and security infrastructure. The on-site switching station/substation will locate the main power transformer/s that will step up the generate electricity to a suitable voltage level for evacuating the power into the national electricity grid, via the OHL. Auxiliary buildings include, inter alia, a control building, offices, warehouses, a canteen and visitors centre, staff lockers and ablution facilities and gate house and security offices.

Figure 1 below depicts a typical layout of a solar PV energy facility.

Figure 1: Typical Layout of a Solar PV Energy Facility

(THE MILLION SOLAR ROOF INITIATIVE – SOLAR SALVATION OR SOLAR SCAM? CALIFORNIA PV SOLAR FARMS – A BITTER HARVEST!, 2014)

Gordonia PV will have a net generating capacity of 100 MW_{AC} with an estimated maximum footprint of ± 215 ha. The approximate area that each component of Gordonia Solar PV will occupy is summarised in Table 1 below.

Table 1: Component Areas and % of Total Project Area

SEF Component	**Estimated Area**	**% of Total Area (± 215a)**	**% of Farm Area (4117.3628 ha)**
PV array	± 205ha	95.3 %	5.0 %
Permanent and construction laydown areas	± 3 ha	1.5%	0.07 %
Auxiliary buildings	± 1 ha	0.45 %	0.02 %
Internal roads	± 6ha	2.93 %	0.15 %
Substation	± 0.5 ha	0.27%	0.012 %

2. LAYOUT DEVELOPMENT

It is customary to develop the final/detailed construction layout of the SEF only once an Independent Power Producer (IPP) is awarded a successful bid under the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), after which major contracts are negotiated and final equipment suppliers identified. However, for the purpose of the Basic Assessment (BA) in accordance with the minimum requirements prescribed by the Department of Environmental Affairs (DEA), two alternative layouts were identified. The following section elaborates on the layout options for Gordonia Solar PV.

2.1 INITIAL ASSESSMENT AREA

An initial/ conceptual area of ± 380 ha was identified during the planning phase of the BA for Gordonia Solar PV. The area is located in the southern portion Geel Kop Farm 456 RE. Figure 2 below depicts the 380 ha initial/ conceptual area outlined in Red.

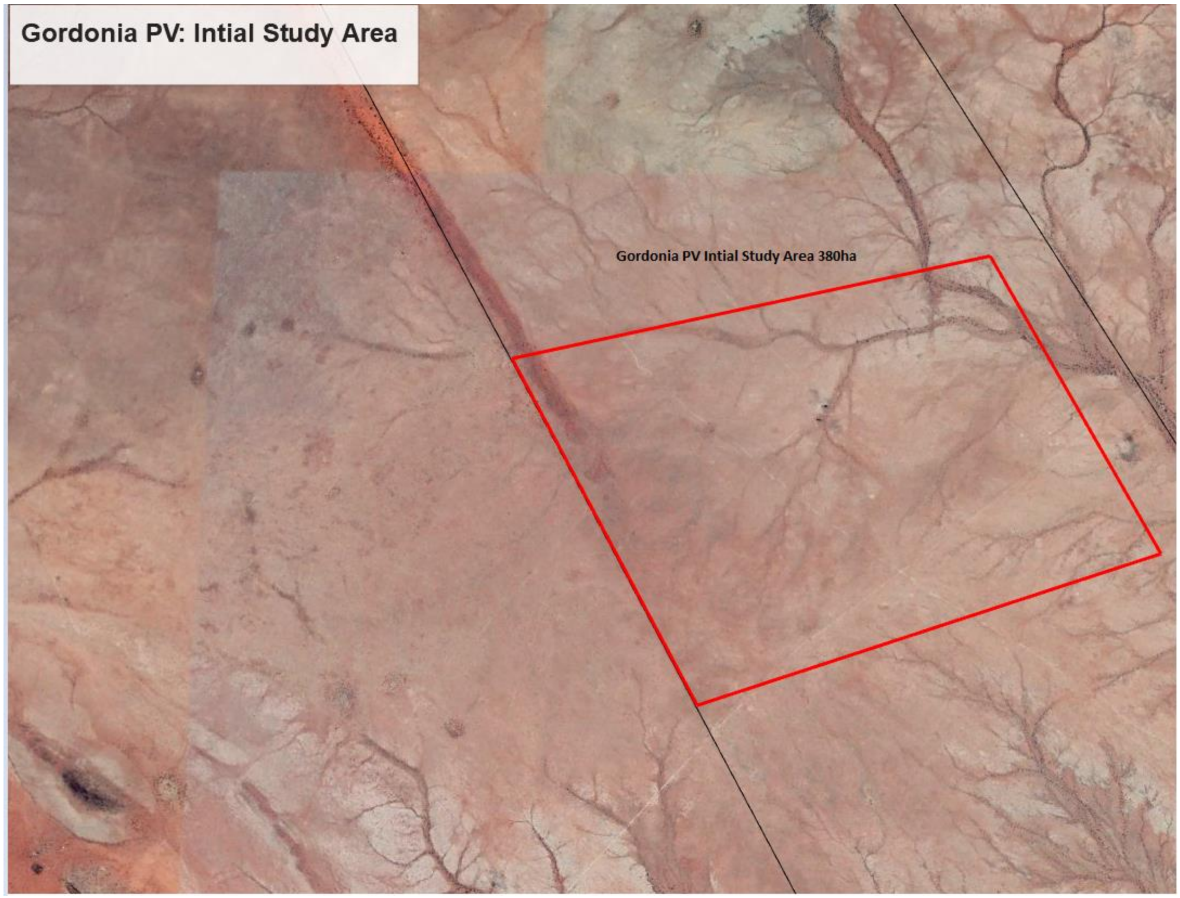

Figure 2: Initial/ Conceptual Area of Gordonia Solar PV

The initial/ conceptual area did not consider any environmental sensitive areas (to be identified by the various specialist studies). This initial/ conceptual area was driven primarily by its proximity to the N14 access road as well as reduced OHL distance to connect into the Upington MTS, located ± 14km to the east of the site.

2.2 SITE SENSITIVITY SCREENING

Following the identification of the initial/conceptual area, various specialists namely ecological, aquatic and avifaunal were appointed to assist in the site selection process in the form of mapping the sensitive area of the initial/ conceptual area following a site visit. These sensitivity files were then used to determine the location of the preferred layout alternative during the planning and design phase, which aimed to avoid all areas with a high and very high sensitivity as indicated in Figure 3 below.

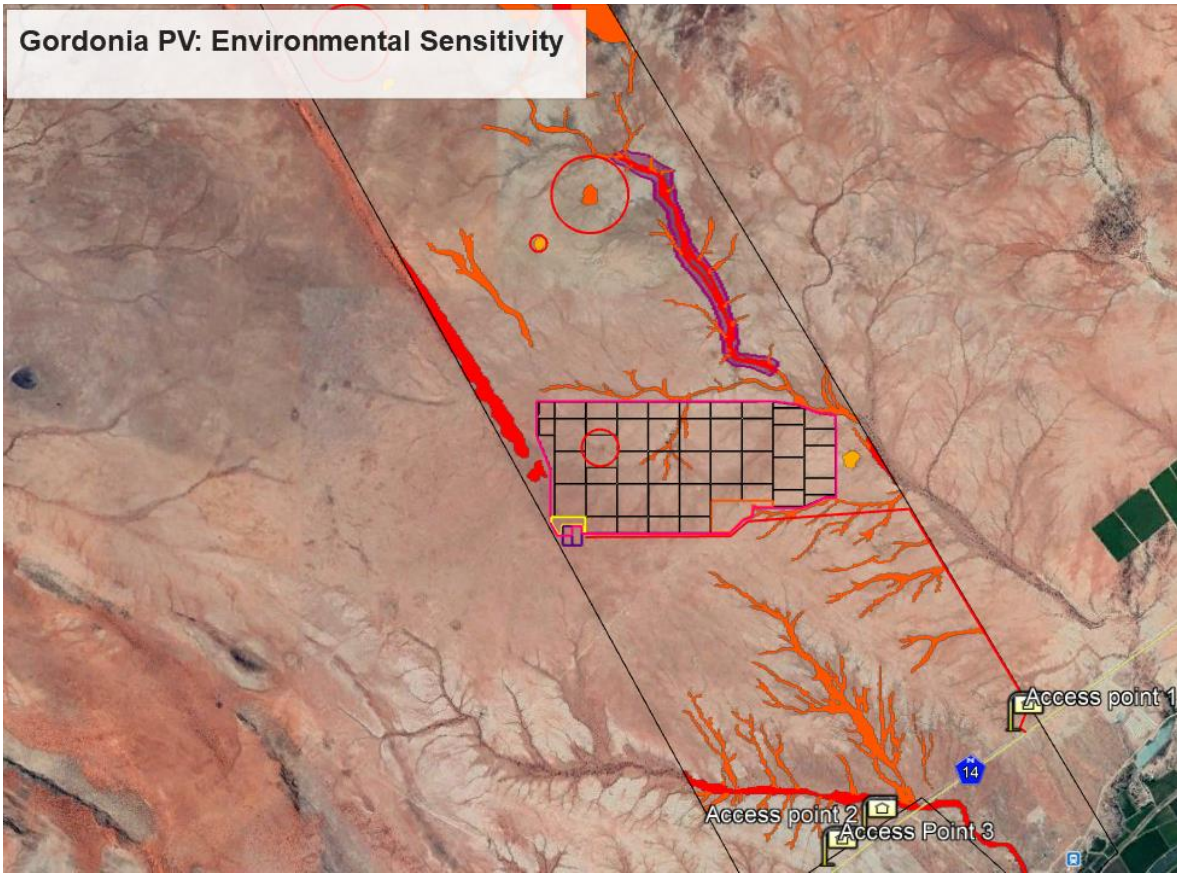

Figure 3: Environmental Site Sensitivity for Gordonia Solar PV located on Geel Kop Farm 456 RE

2.3 LAYOUT ALTERNATIVE 1 (PREFERRED)

Extensive upfront consultation with the various specialists mitigated many of the impacts associated with the planning and design phase. Therefore the preferred layout alternative within the initial/ conceptual area was the only alternative considered for Gordonia Solar PV as depicted in Figure 4 below. Layout Alternative 1 predominantly occupies only Low/Medium sensitivity areas.

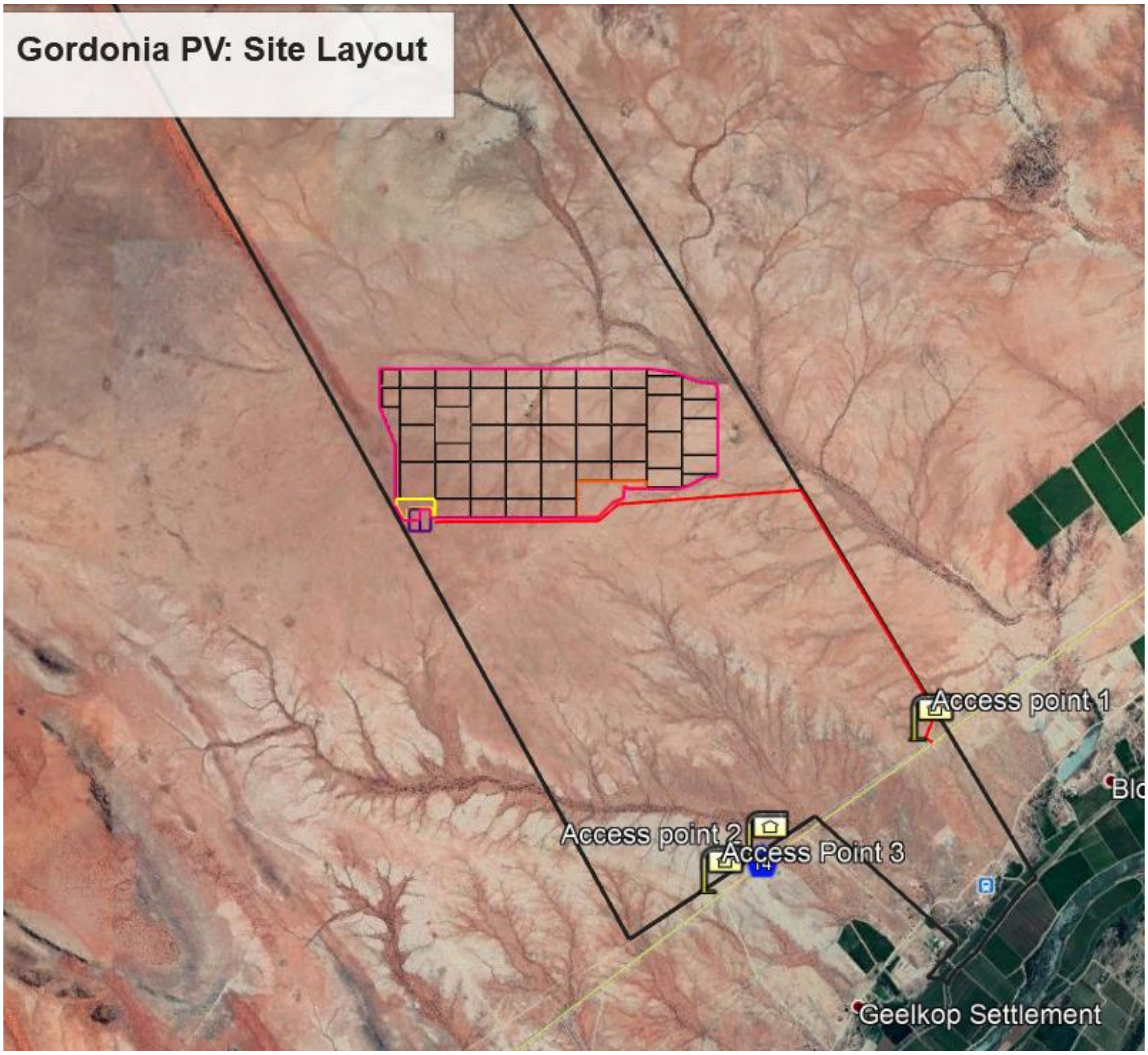

Figure 4: Gordonia PV Site Development Boundary for Gordonia Solar PV

3. OVERVIEW OF THE SOLAR ENERGY FACILITY

The following section presents an overview of the main components of the SEF layout.

3.1 SOLAR ARRAY

Solar PV modules are connected in series to form a string. A number of strings are then wired in parallel to form an array of modules. PV modules are mounted on structures that are either fixed, north-facing at a defined angle, or mounted to a single or double axis tracker to optimise electricity yield.

3.2 MOUNTING STRUCTURES

Various options exist for mounting structure foundations, which include cast/pre-cast concrete (shown in Figure 5), driven/rammed piles (Figure 6), or ground/earth screws mounting systems (Figure 6).

Figure 5: Cast Concrete Foundation
(Solar Power Plant Business, 2013)

Figure 6: Driven/ Rammed Steel Pile
(SolarPro, 2010)

Figure 7: Ground Screw
(PV MAGAZINE, 2014)

The impact on agricultural resources and production of these options are considered to be the same, however concrete is least preferred due the effort required at a decommissioning phase in order to remove the concrete from the soil, and therefore its impact on the environment. Gordonia Solar PV will therefore aim to make the most use of either driven/rammed piles, or ground/earth screws mounting systems, and only in certain instances resort to concrete foundations should geotechnical studies necessitate this.

3.3 AUXILIARY BUILDINGS

The auxiliary buildings will comprise of the following as a minimum:

- Control Building / Centre;
- Office;
- 2 x Warehouses;
- Canteen & Visitors Centre;
- Staff Lockers & Ablution; and
- Gate house / security offices.

The total area occupied is approximately 1 ha, excluding the facility switching station/ substation.

3.4 WASTE MANAGEMENT

3.4.1 Solid waste

Solid waste during the construction phase will mainly be in the form of construction material, excavated substrate and domestic solid waste. All waste will be disposed of in scavenger proof bins and temporarily placed in a central location for removal by the contractor. Any other waste and excess material will be removed once construction is complete and disposed of at a registered waste facility. Excess excavation material will either be spoiled offsite at a registered facility or used for landscaping berms within the overall PV footprint.

3.4.2 Sewerage

During the construction phase, chemical ablution facilities will be utilised. These ablution facilities will be maintained, serviced and emptied by an appointed contractor, who will dispose of the effluent at a licensed facility off site. Once construction is complete, the chemical ablution facilities will be removed from the study area. A conservancy tank which will be regularly emptied by a registered service provider will be installed at the Operations & Maintenance building and on-site substation.

3.4.3 Hazardous substances

During the construction phase, use of the following hazardous substances is anticipated:

- Cement associated with the piling activities and construction of buildings and inverter station plinths.
- Petrol/diesel for construction plant; and
- Limited amounts of lubricants and transformer oils.

Temporary storage and disposal of hazardous waste will be done in compliance with relevant legislation (i.e. stored in covered containers with appropriate bunding). Refuelling areas to be in designated positions, with suitable mitigation to reduce the risk of hydrocarbon spills.

3.5 GRID CONNECTION AND CABLING

Gordonia Solar PV intends to connect to the Upington MTS (400/132 kV) located ± 14km to the east of Bushmanland PV, via the 132kV Geelkop Collector Substation located between Duneveld PV and Gordonia Solar PV Developments. The proposed Gordonia Solar PV substation will be approximately 75m x 150m in size (Facility component) and feature a step-up transformer/s to transmit electricity via a 132 kV OHL directly to the Geelkop Collector Substation and onto the Upington MTS. The OHL is envisaged to be ± 16km in length, a maximum height of 32m and occupy a servitude width of between 52m. Alternatively, Gordonia PV will connect to Upington MTS (400/132 kV), via a loop in loop out (LILO) into the McTaggerts/Oasis 132kV powerline adjacent to the Bushmanland PV Substation.

A 100 MW_{AC} installation will require specific electrical components to meet the national grid code requirements in order to generate and supply electricity into the national grid.

The conversion from DC (modules) to AC is achieved by means of inverter stations. A single inverter station is connected to a number of solar arrays, are will be placed along the internal service roads for ease of access. A number of inverter stations will be installed for the SEF (up to maximum of ± 60 centralised inverters, or a maximum of ± 840 string inverters), each of which is connected to the on-site / facility substation.

Final placement of the inverter stations and on-site/facility substation will need to take ground conditions into consideration. Interconnecting electrical cabling will be trenched where practical and follow internal access roads to the greatest extent. Sensitive areas will consequently be avoided as far as possible, or alternatively, cables will be fastened above- ground to the mounting structures so as to avoid excessive excavation works and clearing of vegetation.

3.6 BATTERY STORAGE

Renewable energy can currently achieve lower costs than fossil fuels. By incorporating energy storage technologies into renewable energy facilities, electricity can be stored during generation peaks and supplied during demand peaks.

Lower costs coupled with improved efficiencies, high energy density, lightweight design and low environmental risks, make Lithium Battery Technologies the preferred alternative. Please see Annexure 1 for the Battery Storage Technical Development Report.

Gordonia PV will include a 400MWh battery that will cover a maximum area of 3.5ha (Figure 8).

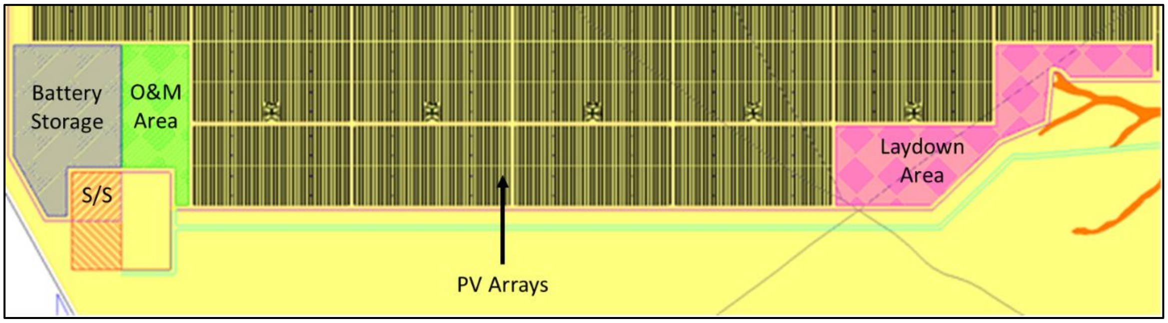

Figure 8: Proposed layout indicating battery storage area.

3.7 ACCESS ROUTES AND INTERNAL ROADS

The proposed project site is accessible via the major national road found in the broader study area, the N14, which connects Upington and Keimoes in a south-west direction.

- Preferred Access point of access will be the eastern access as depicted in Figure 8 below. Access Road 1 (red route in Figure 9) is the most technically and environmentally preferred access road. This route of 4.5km in length connects the Gordonia Solar PV site via the N14 national road along the southern boundary of Geel Kop Farm 456 RE. The proposed access road utilizes an existing farm track which will reduce the environmental impact.

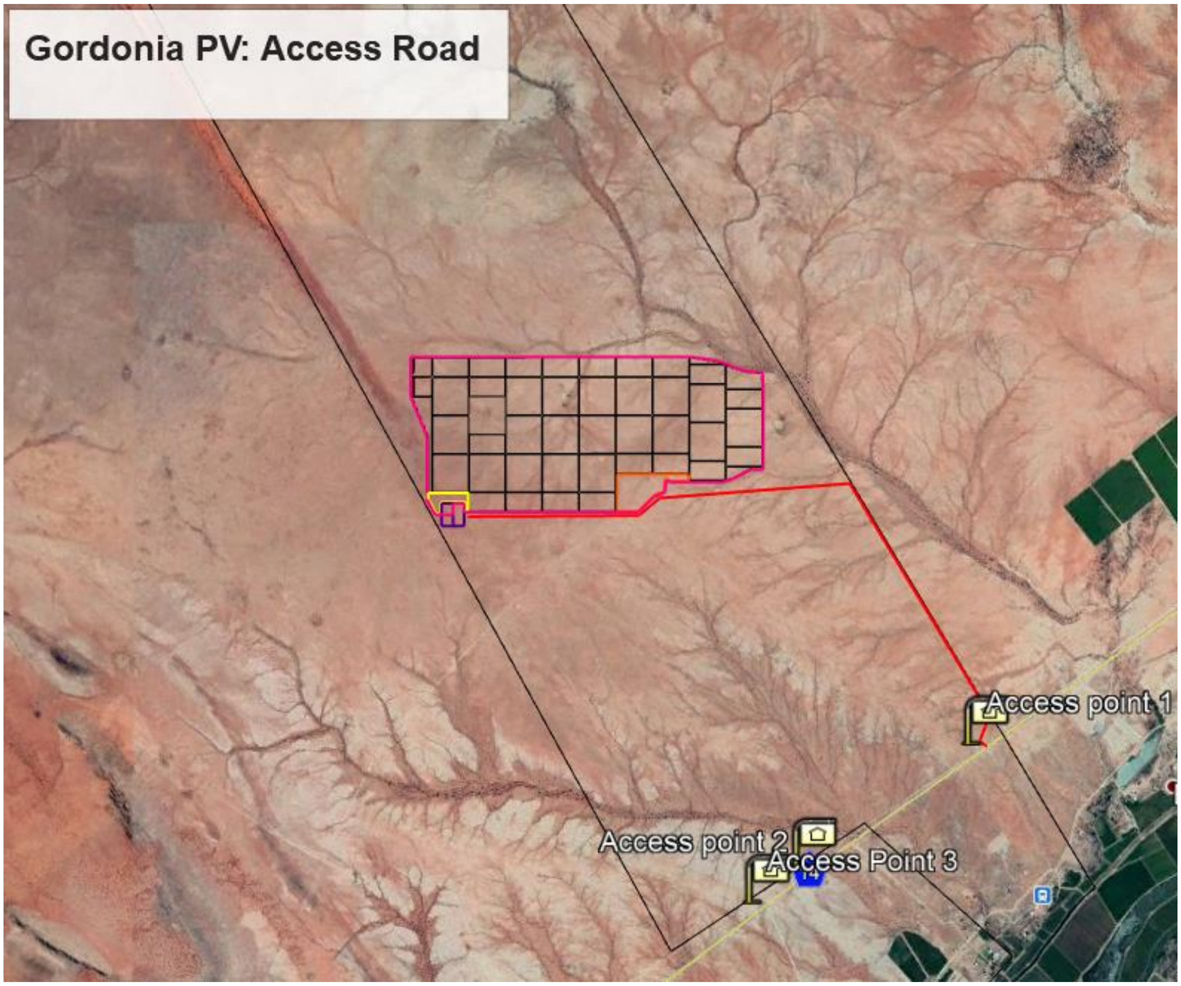

Figure 9: Access Routes to Gordonia Solar PV

The internal road network of the SEF will be gravelled roads, approximately 5m in width, around the solar array periphery. Roads located in-between the solar modules will be un-surfaced tracks to be used for maintenance and cleaning of solar PV panels.

A detailed transport and traffic plan is currently being compiled for the project and will be assessed in the impacts tables of the BA Report. Precautionary measures will be taken to mitigate the risk of ground disturbances where access roads will be constructed. Special attention will be given to drainage, water flow and erosion by applying appropriate building methods.

4. CONCLUSION

Layout Alternative 1 (Preferred) has been developed based on key criteria identified above, including inter alia, already authorised solar footprints, accessibility, assessment of alternatives, proximity to the Upington MTS, as well as consideration of sensitive areas to minimise ecological and other impacts.

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ANNEXURE 1

Gordonia PV: Battery Storage

DESCRIPTION AND LAYOUT REQUIREMENTS

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ACCRONYMS AND ABBREVIATIONS

AC	Alternating Current
CAPEX	Capital Expenditure
DC	Direct Current
DEA	Department of Environmental Affairs
DoE	Department of Energy
EIA	Environmental Impact Assessment
EOL	End of Life
EPC	Engineering, Procurement and Construction
HVAC	Heating, Ventilating, and Air Conditioning
IPP	Independent Power Producer
IRP	Integrated Resource Plan
Li	Lithium
Li-ion	Lithium Ion
KW	Kilowatt
kWh	Kilowatt Hour
MW	Megawatt
MWh	Megawatt Hour
NaS	Sodium Sulphur
NERSA	National Energy Regulator of South Africa
O&M	Operations & Maintenance
OEM	Original Equipment Manufacturer
OPEX	Operating Expenditure
PV	Photovoltaic(s)
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme

1. INTRODUCTION

South Africa has recognised the need to expand electricity generation capacity within the country. This is based on national policy and informed by ongoing planning undertaken by the Department of Energy (DoE) and the National Energy Regulator of South Africa (NERSA).

In recent years, recurring large-scale power cuts (i.e. load shedding) have highlighted the need to improve reliability and resilience of electricity supply.

The Integrated Resource Plan (IRP 2019) sets the direction for the energy sector, with a shift away from coal, increased adoption of renewables and gas, and an end to the expansion of nuclear power. The IRP calls for some 6 000MW of new solar PV capacity and 14 400MW of new wind power capacity to be commissioned by 2030, as current coal generation capacity will be reduced (by over 80%) by 2050.

One of the main challenges faced by Eskom is managing and balancing electricity demand and supply. While renewable sources can now achieve lower costs than fossil fuels, photovoltaic (PV) arrays and wind turbines both have variable electricity production, since they rely on energy inputs that cannot be controlled (i.e. sunshine and wind). For this reason, fossil fuels currently still have a key role in the energy sector as they can provide electricity on demand and when consumption reaches its peak.

However, cost reductions of energy storage technologies and the wider deployment of battery (particularly lithium-ion) installations globally, have now stimulated interest in combining renewable energy generation with energy storage to provide dispatchable energy (i.e. energy on demand) and reliable capacity.

For example, the production peak of PV facilities occurs around noon, whereas electricity demand normally peaks for about two hours in the morning and two hours in the evening (i.e. when the population is at home and using electrical appliances). By incorporating energy storage technologies into renewable energy facilities, the supply of electricity can be controlled by absorbing/storing during generation peaks and supplying power during demand peaks.

2. UNDERSTANDING THE SOUTH AFRICAN LEGISLATION

In March 2020, the Department of Environmental Affairs (DEA) clarified the applicability of listed activities, under the EIA regulations (as amended), which relate to the development and operation of facilities or infrastructure, for the storage, or storage and handling of a dangerous good, where such storage occurs in containers in volumes that may meet or exceed the thresholds specified under the Listing Notices 1, 2 & 3.

As per the DEA's response, installations, facilities or infrastructure related to the development and operation (or expansion and operation) of battery energy storage will not trigger any of these listed activities. Batteries are not regarded as facilities or infrastructure for the storage or storage and handling of a dangerous good, considering that its inherent purpose or objective is not to store, or store and handle a dangerous good. Furthermore, a battery is not deemed to be a "container".

Although a battery will not trigger these listed activities, the following should be noted:

- There may be instances where the battery is not fully assembled and the electrolyte (or substance making up the electrolyte) intended for the battery, may be stored in a container on site prior to filling. In these instances, these activities would be applicable as the purpose would be the storage of that substance (if indeed a dangerous good), and not the storage of energy.

- Battery storage facilities have the potential to trigger other listed or specified activities. It is therefore important to consider all other listed and/ or specified activities in the context of the development and relevant scenario. All listed or specified activities that will be triggered by the development must be identified, described and assessed in the EIA.

In the case of this application, while other listed activities are triggered, no electrolyte nor dangerous good will be stored in a container on site in volumes that may meet or exceed the thresholds specified in EIA regulations. Therefore, activities relating to the storage and handling of a dangerous good, where such storage occurs in containers, will not be triggered.

3. OVERVIEW OF THE ENERGY STORAGE FACILITY

3.1 TECHNOLOGY

Unlike conventional energy storage facilities, such as pumped hydro, battery storage has the advantage of being flexible in terms of site location and sizing. Therefore, they can be incorporated into, and placed in close proximity, to a wind or solar facility. They also have the advantage of being easily scaled and designed to meet specific demands.

Different battery storage technologies, such as lithium-ion (Li-ion), zinc hybrid cathode, sodium ion, flow (e.g. zinc iron or zinc bromine), sodium sulphur (NaS), zinc air and lead acid batteries, can be used for grid applications. Compared to other battery options, Li-ion batteries are highly efficient, have a high energy density and are lightweight. As a result of the declining costs, Li-ion technology now accounts for more than 90% of battery storage additions globally (IRENA, 2019).

Therefore, in line with the above, we propose that Lithium Battery Technologies be considered as the preferred technology.


(Tesla, 2019)

Figure 1: Tesla's Megapack Li-ion Battery (Modular System).

3.2 SIZE OF THE BATTERY

Our design aims to provide two hours of stored energy during the morning and evening demand peaks (i.e. four hours of stored energy per day). The size of the battery will depend on the net output (MW_{AC}) of the facility. For example, assuming a 75 MW_{AC} PV plant grid limitation, we could export 300 MWh ($75MW_{AC}$ x 4 hours) per day. Hence a 300 MWh battery would be required.

The table below provides the battery sizes required, based on net output of the facility, to supply four hours of stored energy per day.

Table 1: Battery Sizes.

Facility net output	Battery Size
75 MW_{AC}	300 MWh
100 MW_{AC}	400 MWh
140 MW_{AC}	560 MWh
200 MW_{AC}	800 MWh

3.3 LOCATION AND SIZE OF THE BATTERY STORAGE AREA

The battery storage facility will be constructed preferably adjacent to the on-site substation.

The size of the battery storage area required will depend on the specific manufacturer. Based on our research, the area required typically ranges from 12kWh/m^2 to approximately 120kWh/m^2. These calculations include all additional support equipment and any necessary clearances between Battery Modules/Containers.

It is customary to develop the final detailed design of the facility only once an Independent Power Producer (IPP) is awarded a successful bid under the Renewable Energy Independent Power Producer Procurement Programe (REIPPPP), after which major contracts are negotiated and final equipment suppliers identified. Therefore, at this stage the exact supplier/manufacturer has not yet been identified. However, for the purpose of the EIA in accordance with the minimum requirements prescribed by the Department of Environmental Affairs (DEA), we would adopt the conservative approach and apply for and assess an allowance of 12kWh/m^2.

The table below provides the battery storage areas required, based on the most conservative requirement of 12kWh/m^2.

Table 2: Battery Storage Area.

Battery Size	Battery Storage Area (Maximum)
300 MWh	2.5 ha
400 MWh	3.33 ha
560 MWh	4.66 ha
800 MWh	6.66 ha

The figure below illustrates the 100 MW/129 MWh Li-ion battery storage facility at Hornsdale wind farm in Australia. The total battery storage area is less the 1 hectare.


(Aurecon, 2018)

Figure 2: The 100 MW/129 MWh Li-ion battery coupled with the Hornsdale wind farm in Australia.

3.4 GENERAL COMPONENTS

The exact design will depend on the manufacturer, however traditional utility-scale Li-ion battery storage facilities include the following main components:

1. Battery cells → modules → packs → racking system (DC).
2. Storage container (HVAC system, thermal management, monitors and controls, fire suppression, switchgear, and energy management system).
3. Power conversion system (bidirectional inverter to convert AC to DC for battery charging and DC to AC for discharging).
4. Transformer (to step up 480-V inverter output to 12–66 kV).

Figure 3 illustrates the components that generally make up the primary battery system, Figure 4 is a typical flow diagram of a PV plant with battery storage and Figure 5 is a conceptual example of a typical battery storage facility.

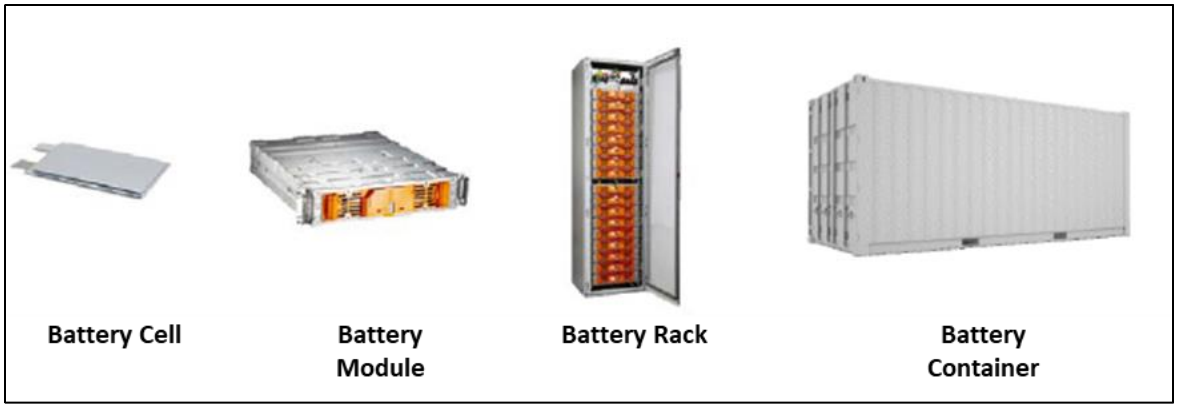

Figure 3: Typical Battery System Components.

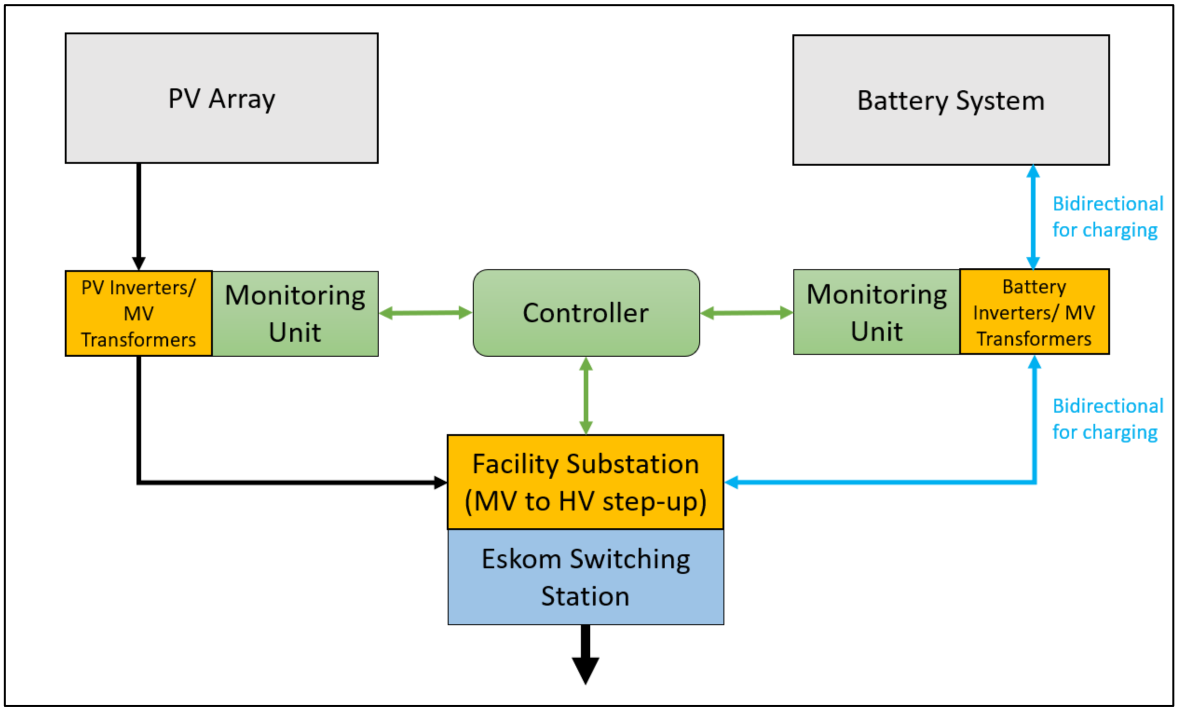

Figure 4: Typical flow diagram of PV plant with battery storage

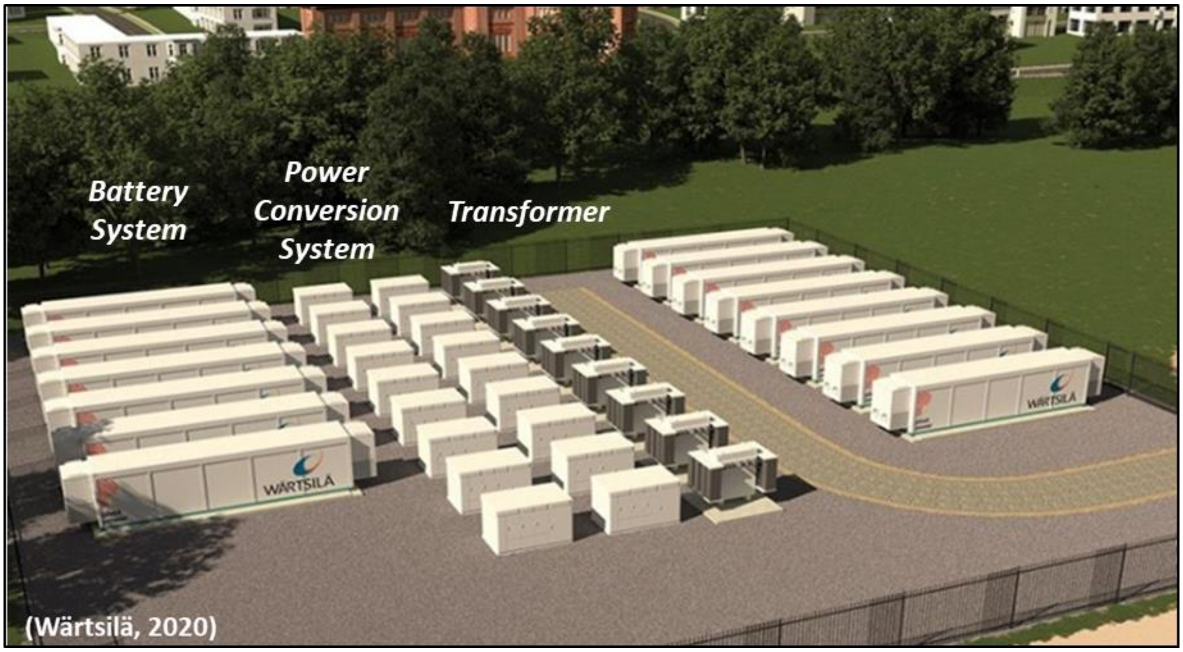

Figure 5: Pivot Power's proposed 50MW lithium-ion battery in Kemsley, Kent.

In the case of Tesla's new Megapack Modular System (Figure 6), each Megapack arrives from the factory fully-assembled and pre-tested in one containerised/modular enclosure—including battery modules, bi-directional inverters, a thermal management system, an AC main breaker and controls.

No assembly is required on site which significantly reduces complexity and ensures an easy installation and connection process. These compact modules also increase the energy density of the battery, reducing the amount of space required (Tesla, 2020). Figure 6 C) is a conceptual design of a 160 Tesla Megapack battery storage facility. By way of comparison, a 400 MWh storage facility (see Table 2 above) would require in the order of 192 Megapacks.

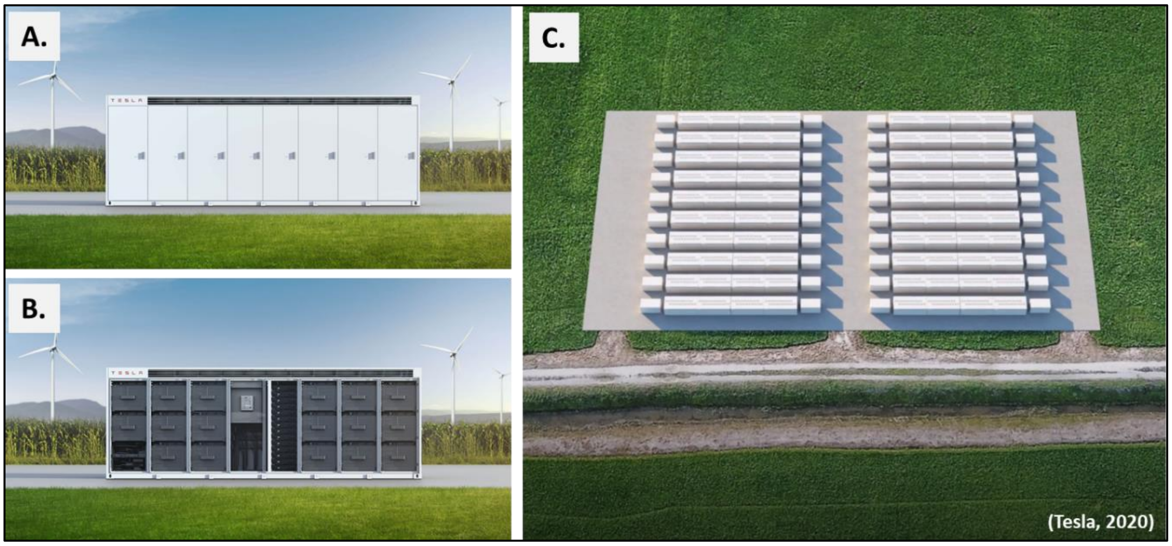

Figure 6: A & B) Single Megapack. C) Conceptual design of Megapack battery storage facility containing 160 Megapacks.

3.4.1 Battery module/container dimensions

Based on our research each manufacturer has slightly different individual battery container/module dimensions, however they all typically fall within the following ranges:

- Length: 6m – 12m
- Width: 1.5m – 2.5m
- Height: maximum of 3m

3.4.2 Foundation

It is likely that the batteries will require a solid foundation/ plinths, such as a concrete pad, grade beams or a structural steel deck. These will need to be strong enough to support the equipment and large enough to account for any necessary equipment clearances.

The final foundation design will be undertaken by a relevant qualified civil or structural engineer. The design will be in accordance with local building standards.

3.4.3 Perimeter Fence

A perimeter fence of approximately 2.1m high will be installed around the battery facility. Only authorised persons will be allowed to enter the battery storage facility.

4. INSTALLATION

4.1 SEQUENCE

The installation process typically includes the following activities:

1. Site clearing;
2. Site preparation (laying foundations etc.);
3. Delivery (transported to site on a flatbed trailer);
4. Unloading (with the use of cranes and the necessary rigging equipment);
5. Anchoring Containers/ Modules;
6. Wire and cable connections;
7. Commissioning and miscellaneous fine tuning; and
8. Electrical inspection and testing.

It is important to note that this is an iterative process, as can be seen in Figure 7.

Figure 7: Installation of the 100 MW/129 MWh Li-ion battery at the Hornsdale wind farm.

4.2 INDICATIVE COSTS

The indicative cost of a battery storage system is expected to range between ZAR 5,680 and ZAR 9,480 per kWh, inclusive of the battery modules/ containers, inverters, controllers, battery management system, cabling, delivery, warranties and commissioning supervision. For a 300 to 400 MWh storage facility, this equates to a range of between ZAR 1.7 billion and ZAR 3.8 billion capital expenditure (CAPEX), over and above the cost of the conventional solar PV facility.

The indicative installation cost of a battery storage system is expected to range between ZAR 840 and ZAR 2,520 per kWh. For a 300 to 400 MWh storage facility, this equates to a range of between ZAR 252 million and ZAR 1 billion for the installation, over and above the cost of the conventional solar PV facility and cost of the battery storage system.

The indicative operating expenditure (OPEX) of the battery storage system is expected to range between 2 and 3% of CAPEX per annum, therefore between ZAR 34 million and ZAR 114 million per annum for a 300 to 400 MWh system.

4.3 INDICATIVE EMPLOYMENT FIGURES

It is estimated that the construction of the battery storage system will require a maximum of 50 personnel including the proprietary equipment supplier's installation and supervisory team. This is over and above the total Engineering, Procurement and Construction (EPC) workforce required to construct the solar PV facility. Furthermore, it is expected that a maximum of 5 personnel will be required to operate and maintain the battery storage system, over and above the Operations & Maintenance (O&M) workforce required for the solar PV facility.

5. MAINTENANCE

Any maintenance, service or repairs required to be carried out on the proprietary battery storage equipment will be conducted by the supplier's personal or their authorised agent. This includes any preventative maintenance that is identified to be carried out on the plant.

Any necessary maintenance equipment and spares will be kept in the renewable energy facility general maintenance building and/or storage area. No hazardous or dangerous goods will be stored in a container on site in volumes that may meet or exceed the thresholds specified in EIA regulations.

It should be noted that it is highly unlikely that battery modules will be stored on site for strategic spares purposes. Most Lithium Battery Technologies have a recommended depth of discharge of 80%, meaning that the life of the battery will significantly increase if the depth of each discharge is limited to 80% of the rated capacity. It is therefore detrimental for battery cells to be stored for long periods on site, as they may discharge below their recommended limit (potentially down to 100% depth of discharge) and potentially become unusable. It is therefore very likely that battery modules will be shipped to site on a needs-be basis during operation of the plant.

6. DECOMMISSIONING AND DISPOSAL PROCEDURES

Lithium battery products contain several recyclable materials (e.g. nickel, cobalt, copper, aluminium, steel, and lithium), and the majority of proprietary suppliers advocate recycling of their products. When a battery module reaches its end of life (EOL) or needs to be replaced for a specific technical reason, it will be returned to the supplier's facility for disassembly and further processing.

Decommissioning and disposal of batteries will always be in accordance with South African Regulations. In some cases, batteries will be disposed of without returning to the supplier. In this instance, local recycling processors may be used adhering to appropriate methods for disposal and recycling, and where required, under surveillance from the original equipment manufacturer (OEM).

It must be noted that the specific Lithium Battery Technologies under consideration do not contain heavy metals such as lead, cadmium, or mercury, which therefore facilitates the safe use and disposal of these technologies.

Our research shows that the majority of OEMs operate a formal battery recycling plan as they strive to retrieve all batteries out in the field that have reached EOL for purposes of recycling. These plans are constantly evolving as OEMs work to further improve their methods of recycling their products.

7. SAFETY AND ENVIRONMENT

7.1 GENERAL CARE DURING CONSTRUCTION AND OPERATION

Batteries are energy storage devices, whether single cell batteries or a collection of battery packs which assembled with other systems, make up a high-capacity containerised battery solution. As with most battery products, care should be taken not to short circuit, puncture, crush, immerse, force discharge or expose to temperatures outside of the recommended safe operating temperature range of the Lithium Battery Technology. Standard measures will need to be implemented to ensure the safe installation and operation of battery modules, as well as to prevent unauthorised entry into the battery storage area during construction and operation.

7.2 HIGH VOLTAGE HAZARD RISKS

A battery storage system poses standard high voltage hazard risks that need to be managed during construction and operation. A significant high voltage and electrocution risk will exist if the various equipment enclosures and/or safety circuits are compromised or damaged. A battery pack contains a substantial electrical charge and can lead to injury or death if mishandled. If a component in the battery module has been significantly visibly damaged or its enclosure compromised, then it is recommended to follow appropriate high-voltage preventative measures until the danger has been assessed by a suitably qualified person.

7.3 OPERATING TEMPERATURE RANGES

The various Lithium Battery Technologies are designed to operate within recommended safe operating temperature ranges. The final supplier selection will therefore need to consider site climatic conditions to ensure the health of the unit. Prolonged exposure to temperatures outside of the safe operating range can drive battery cells into thermal runaway and result in a fire.

7.4 THERMAL MANAGEMENT SYSTEMS

Lithium Battery Technologies include sealed thermal management systems which contain coolants and/or refrigerants. Mechanical damage of the sealed thermal management system may result in leakage of the coolant. Considering that the battery modules are containerised solutions, it is highly probable that any spillage will occur only within the confines of the enclosure, and therefore pose a negligible risk of contamination to the environment.

7.5 RISK OF ELECTROLYTE LEAKAGE

There is a very low risk associated with leaked electrolyte from battery cells. This may vary depending on the specific Lithium Battery Technology. In the case of a Li-ion cell, the electrolyte is largely absorbed in the electrodes within individual sealed cells. There is therefore little free liquid electrolyte, and hence a negligible risk of spillage. Should this occur, it would be within the confines of the enclosure. It is assumed that this would be the case for most Lithium Battery Technologies.

8. CONCLUSION

Renewable energy can currently achieve lower costs than fossil fuels. By incorporating energy storage technologies into renewable energy facilities, electricity can be stored during generation peaks and supplied during demand peaks.

Lower costs coupled with improved efficiencies, high energy density, lightweight design and low environmental risks, make Lithium Battery Technologies the preferred alternative.

9. LIST OF REFERENCES

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