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LITHIUM-ION BATTERY ENERGY STORAGE SYSTEM HIGH LEVEL RISK ASSESSMENT FOR THE PROPOSED AMENDMENT OF THE EA FOR THE AUTHORISED BLOEMSMOND 1 PV DEVELOPMENT ON PORTIONS 5 AND 14 OF THE FARM BLOEMSMOND 455

This risk assessment is appended to the Revised EMPr developed, specifically to incorporate a Battery Energy Storage System within the authorised footprint of the facility. An environmental application process was initiated to amend the EA and EMPr for the authorised facility and this risk assessment is submitted as part of this environmental process.

1. PROJECT DESCRIPTION

The Bloemsmond 1 PV Development received an environmental authorisation for a 75 Megawatt PV Energy facility with associated infrastructure on 26 April 2016. This EA was amended on 13 March 2020 to increase the generation capacity of the facility to 100MW.

The current amendment process is for the inclusion of a 500 MegaWatt Hour (MWh) Battery energy Storage System on a footprint of up to 4.17ha within the authorised footprint of the development.

2. MOTIVATION

South Africa has recognised the need to expand electricity generation capacity within the country and to improve reliability and resilience of electrical supply. 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).

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. One of the main challenges faced by Eskom is managing and balancing electricity demand supply. While renewable resources can now achieve lower costs than fossil fuels, photovoltaic (PV) arrays and wind turbines both have variable electricity production, since they relay on energy inputs that cannot be controlled, particularly at peak consumption periods.

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

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

Different battery storage technologies, such as lithium-ion (Li-ion), zinc hybrid cathode, sodium ion, flow (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 declining costs, Li-ion technology now accounts for more than 90% of battery storage additions globally (IRENA, 2019).

In line with this practise, the applicant is proposing the use of Lithium Battery Technologies, such as Lithium Iron Phosphate (LFP) or Lithium Nickel Manganese Cobalt oxides (NCM).

The proposed design aims to provide up to five hours of stored energy per day for the demand peaks. The size of the battery depends on the net output (MWAC) of the PV facility. Assuming a 100 MWAC PV plant grid limitation, up to 500MWh (100MWAC x 5 hours) per day could be exported to battery storage. This would require a 500MWh battery.

The proposed Battery Energy Storage System (BESS) is proposed on the approved footprint, preferably adjacent to the on-site substation. The size of the battery storage area is dependant on specific manufacturer but conservatively the area calculation is 12kWh/m². Thus, the required area for a 500MWh BESS will be 4.17ha.

This will be achieved by consolidating and altering auxiliary footprint areas identified in the approved EA to accommodate the BESS. The approved footprint will not increase in size. As part of this Amendment Application, the revised layout plans will be submitted to the department.

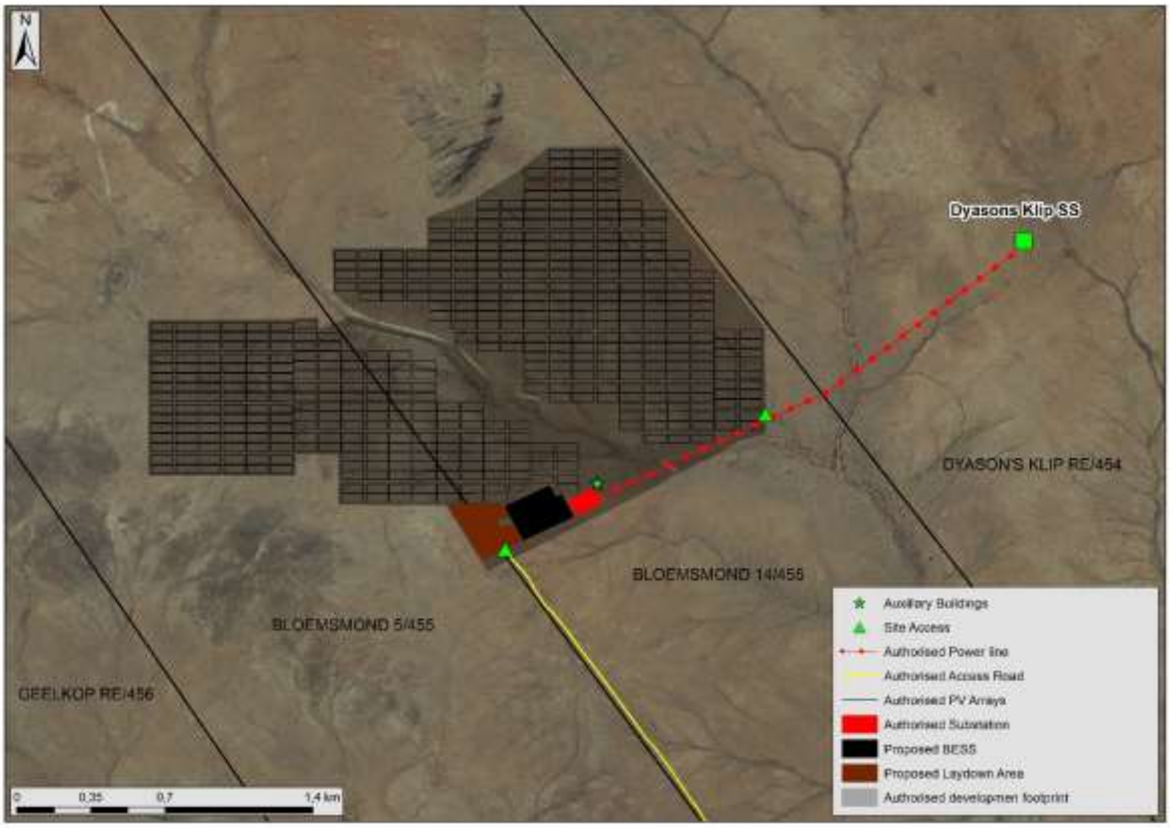
The exact design specifications will depend on the battery manufacturer, however traditional utility scale Li-ion battery storage facility include the following main components:

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 12-66kV.

The inclusion of a BESS into renewable energy facilities is an important step in securing peak demand energy in South Africa. It falls in line with all the relevant policies and programmes that are driving renewable energy development.

3. LAYOUT PLAN SHOWING BESS

The plan below shows the location of the BESS in relation to the authorised footprint of the facility.



The brown polygon in the image above shows the proposed BESS in relation to the authorised footprint of the PV Facility (grey opaque polygon). The full-sized layout plans are appended to the Amendment Assessment Report and application for amendment form.

4. RISK ASSESSMENT

The risks associated with lithium-ion (Li-ion) battery technologies are generally well understood and researched. The primary risks relate to fire hazards and the potential for a condition known as 'thermal runaway'. Thermal runaway occurs in situations where an increase in temperature changes the conditions in a way that causes a further increase in temperature, often leading to a destructive result.

In terms of general environmental risks, these have been identified as the mining for the materials used in batteries and the disposal at end of life. This report does not address any impacts associated with the mining of lithium for the production of Li-ion batteries but is only concerned with the risks associated with onsite use of battery energy storage systems (BESS) for PV facilities.

This probability risk assessment is based on four main principles (questions that need answering):

1. What could go wrong? In other words what are the actual risks (column 1 and 2).
2. What is the likelihood of something going wrong? In other words, how likely is it that the identified risks could occur (column 3).
3. How bad would it be if something went wrong? In other words, what would the actual impact be should one of the identified risks take place (column 4).
4. What additional management actions and/or mitigations need to be in place to reduce the risk and limit the impact of the risk (column 5).

Risk / Impact	Discussion	Likelihood of Risk	Impact of risk	Management / Mitigation
BESS component / equipment risks				
Mishandling	Considering that a battery is a source of energy, there is a danger that should it be punctured, incinerated, crushed, immersed, have a forced discharge or exposed to temperatures above the declared operating temperature range of the product, there is a risk that an internal or external short circuit may occur. An internal or external short circuit can cause significant overheating which in some cases could result in fire, that could affect surrounding materials or materials within the cell or battery.	Low	Electrocution. On site fires. Electrical failure. Potential spillage of electrolytes (very low likelihood with lithium batteries).	Training and well managed operations and maintenance. Under normal conditions of use, the electrode materials and electrolyte they contain are not exposed, provided the battery integrity is maintained and seals remain intact. Risk of exposure may occur only in cases of abuse (mechanical, thermal, electrical).
Mechanical Damage	If batteries are not properly stored when not in use prior to installation, there is a possibility that mechanical damage may occur leading to: • Leaked battery pack coolant • Leaked refrigerant • Leaked cell electrolyte • Rapid heating of individual cells due to exothermic reaction of constituent materials (cell thermal runaway), venting of cells, and propagation of self-heating and thermal runaway reactions to neighbouring cells. • Fire	Low	On site fires. Electrical failure. Potential spillage of electrolytes or refrigerant.	Adequate on-site management during the construction and operations and maintenance periods.
Leaked Coolant or Refrigerant	Thermal management of some Li-ion battery packs is achieved via liquid cooling using coolant or refrigerant products. Mechanical damage of a battery pack that has been installed could result in leakage of the coolant. The fluid is generally blue in colour and does not emit a strong odour. This coolant if released has toxicological hazards and ecological effects as well as additional impacts relating to the disposal of leaked fluids. Additionally, extended exposure of the battery system to leaked coolant could cause additional damage to the product such as corrosion and compromising of protection electronics.	Low	Potential spillage of electrolytes. Ecological damage. Electrical failure.	Maintenance. Source from reputable manufacturers. Safe and appropriate storage. Safe handling which must include battery inspection prior to installation.

Risk / Impact	Discussion	Likelihood of Risk	Impact of risk	Management / Mitigation
Vented Electrolyte	Li-ion cells are sealed units, and thus under normal usage conditions, venting of electrolyte should not occur. If subjected to abnormal heating or other abuse conditions, electrolyte and electrolyte decomposition products can vaporize and be vented from cells. Accumulation of liquid electrolyte is unlikely in the case of abnormal heating. Vented gases are a common early indicator of a thermal runaway reaction – an abnormal and hazardous condition.	Low	On site fires. Electrical failure. Vent gases.	Maintenance. Source from reputable manufacturers. Safe and appropriate storage. Safe handling which must include battery inspection prior to installation.
Thermal Runaway (TR)	Li-ion battery thermal runaway occurs when a cell, or area within the cell, achieves elevated temperatures due to thermal failure, mechanical failure, internal/external short circuiting and electrochemical abuse. At elevated temperatures, exothermic decomposition of the cell materials begins. Eventually, the self-heating rate of the cell is greater than the rate at which heat can be dissipated to the surroundings, the cell temperature rises exponentially, and stability is ultimately lost. The loss in stability results in all remaining thermal and electrochemical energy being released to the surroundings. It's widely accepted that most TRs are caused by mechanical, electrical or thermal abuses.	Low	On site fires. Electrical failure. Potential spillage of electrolytes.	Maintenance. Despite various factors that may lead to TR, materials including electrode materials as well as electrolytes, and battery design such as negative/positive capacity ratio and venting control, to name but a few, are the intrinsic approaches to enhance the battery safety. Source from reputable manufacturers. Safe and appropriate storage. Safe handling which must include battery inspection prior to installation. Development and implementation of Thermal Management Plan.
Limited knowledge and experience of First Responders to deal with emergency incidents.	As this technology is relatively new in a South African context, the first responders in an unlikely event of an incident may not have the necessary knowledge or experience to deal with an emergency situation such as fire or leakage.	Low	Fire. Electrocution. Injury. Inability to contain spillage.	During the construction phase of the project, first responders from the nearest major centre (such as fire fighters and paramedics) must be given appropriate training on dealing with any emergency situation that may occur as a result of the BESS. Such training must be provided by the technology suppliers or an appointed service provider.

Risk / Impact	Discussion	Likelihood of Risk	Impact of risk	Management / Mitigation
				Appropriate warnings and Standard Operating Procedure for emergency events must be developed and must be provided to the local emergency services and the O&M staff on site.
Disposal at end of life	Disposal of Li-ion batteries to landfill is problematic and recycling should be prioritised. Research in Australia found that just 2% of the country's 3,300 tonnes of Li-ion waste is recycled. South Africa fares far worse (as of November 2019, there was no Li-ion battery recycling facility in South Africa (eWASA)) and Li-ion batteries along with significant amounts of e-waste are not properly disposed of or sent for recycling. In addition to the lithium, manufacturers are secretive about what actually goes into their batteries, which makes it harder to recycle them properly. And while lithium itself isn't of great concern from a pollution angle, these batteries do contain metals like cobalt, nickel, and manganese. The potentially toxic materials contained in batteries means that they are classified as hazardous materials in terms of NEM:WA. There are only a few licensed hazardous waste sites in South Africa and recycling of batteries and e-waste has been identified as a sure way of improving the lifespans of such sites.	High	Potential scenario of fluids from the batteries leaking into environment. The release of such chemicals through leaching, spills or air emissions can harm communities, ecosystems and food production.	Recovery of metals at end of life can significantly reduce these life cycle impacts. This is because the extraction and processing of virgin materials are key contributors to impacts for all battery chemistries. Prior to commencement of the activity, a dedicated Battery Recycling Programme must be compiled and adopted.
General Environmental Risks				
Hydrocarbon Spillage	The BESS area will contain transformers which contain oil for cooling (unless air-cooled). Temporary fuel storage will take place during the construction phase.	Low	Contamination of land and adjacent water resources.	Implementation of the Management actions already included in the EMPr.
Physical damage to surrounding natural areas	Construction activities if not properly managed could impact on areas outside of the construction footprint.	Medium	Physical damage to habitat.	Implementation of the Management actions already included in the EMPr particularly in relation to the demarcation of no-go areas.

Risk / Impact	Discussion	Likelihood of Risk	Impact of risk	Management / Mitigation
Impact on species of conservation concern	The transformation of habitat associated with the BESS, may have a direct impact on species of conservation concern.	Medium	Loss of individual plants within the footprint of the BESS.	Implementation of the Management actions already included in the EMPr. Compliance with the conditions of the Threatened or protected species (TOPS) permits. Undertaking plant rescue in compliance with the plant rescue and protection plan.
Concrete contamination	Run off from concrete civil works could contaminate surrounding areas.	Low	Contamination of land and surrounding water resources.	Implementation of the Management actions already included in the EMPr. Use of ready-mix concrete and the limitation of on-site batching.
Dust	Dust fall out from construction activities.	Medium	Health and safety impacts. Impacts on surrounding vegetation.	Implementation of the Management actions already included in the EMPr. Implementation of a dust fall out monitoring programme.
Protection of Archaeological Resources	Subterranean resources could be exposed during excavations.	Low	Loss of archaeological resources.	Implementation of the Management actions already included in the EMPr. ECO Inspection of all excavations. Compliance with requirements of SAHRA authorisation.
Loss of topsoil resources	All construction activities will have the possibility to impact on topsoil resources.	Low	Loss of Topsoil Contamination of Topsoil.	Implementation of the Management actions already included in the EMPr particularly with regard to topsoil handling and the stripping and stockpiling of topsoil from the BESS footprint prior to construction.

Risk / Impact	Discussion	Likelihood of Risk	Impact of risk	Management / Mitigation
Noise Impact	Although the proposed development is located outside of an urban area, construction noise could have an impact on sensitive receptors.	Low	Impact on health and safety of construction staff. Impact on displacement of fauna.	Implementation of the Management actions already included in the EMPr and compliance with the relevant legislation with respect to noise inter alia Section 25 of ECA (73 of 1989) and standards applicable to noise nuisances in the Occupational Health and Safety Act (No. 85 of 1993).
Siltation and erosion	Stormwater and wash water have the potential to cause erosion or pollution of the receiving environment.	Low	Contamination of surrounding land. Impact on water Quality.	Implementation of the Management actions already included in the EMPr. Implementation of the Stormwater Management Plan.
Theft and other crime.	An increase in crime during the construction phase is often a concern during the development of the overall facility, including the BESS. This is likely to be negligible due to the extremely remote nature of the site.	Low	On site theft. Theft at surrounding properties.	Implementation of the Management actions already included in the EMPr. Implementation of a site security plan.
Wildfires	The solar development site including the BESS is arid, with sparse vegetation cover and fires are not a natural phenomenon in the area. However, under exceptional circumstances, such as following years of very high rainfall, sufficient biomass may build up to carry fires.	Low	Damage to infrastructure.	Implementation of the Management actions already included in the EMPr. Maintaining a firebreak around the total project footprint in the form of a perimeter road.

5. CONCLUSION

A comprehensive operations and maintenance programme is necessary to ensure that all management and mitigation measured listed above and included in the revised EMPr are adopted and implemented as well as to ensure that all monitoring and protective devices are in good working order.

Regular inspections should be undertaken to ensure the battery systems are not overheating or showing signs of malfunction. Annual thermographic scanning can help ensure the BESS is operating within normal parameters.

This high-level risk assessment must be replaced with a detailed technology specific risk assessment once the final equipment suppliers have been identified during the detailed design and procurement stage.