3 PROJECT DESCRIPTION

3.1 Introduction

Electricity supply throughout the world is undergoing a revolution. At a global level this is being caused mainly, but not solely, by electricity utilities having to meet new pressures resulting from global markets, where national governments are open to foreign investors to help fund power sector expansion and development. As a result, utilities have to act as businesses. South Africa is not immune to these forces, and will have to move broadly in line with developments taking place in the rest of the world, while also ensuring that the supply industry evolution meets South Africa's special requirements. At a local level, the main drivers for change in South Africa are potential economic efficiency gains and technological change - for example, different economies of scale in power plant construction, and new information and control technologies (White Paper on the Energy Policy of the Republic of South Africa, December 1998).

The South African Government is currently targeting a six percent economic growth rate, which is equivalent to an average increase of four percent in electricity demand. Eskom is currently experiencing increased demand in excess of four percent. Based on Eskom's projections, there is a requirement for more than 40 000 Megawatts (MW) of new electricity generating capacity over the next 20 years in South Africa. A number of new coal fired power stations are currently being considered, with two new base load power stations approved to come on-line between 2012 and 2016. However, these are not sufficient to meet the demand for electricity and additional power stations will be required.

The Eskom Conversion Act, 2001 (Act No. 13 of 2001) establishes Eskom Holdings Limited (Eskom) as a State Owned Enterprise (SOE), with the Government of South Africa as the only shareholder, represented by the Minister of Public Enterprises. The main objective of Eskom is to provide energy and related services including the generation, transmission, distribution and supply of electricity, and to hold interests in other entities.

3.2 Need and Justification for the project

Koeberg Nuclear Power Station is the only nuclear power station in Africa. It boasts the largest turbine generators in the Southern Hemisphere and is the most southerly-situated nuclear power station in the world. Being a nuclear power station, it is vital that the reliability of the electrical infrastructure associated with this power station is never compromised. The station is also critical for grid stability in the Cape.

The Koeberg 400 kV GIS busbar is due for refurbishment. It has been in operation for almost 30 years; over 8 failures related to post insulators since commissioning has been experienced. The biggest concern with these types of failures is that they result in long duration outages. To maintain the reliability of this system, life extension interventions need to be carried out. Areas of concern have been identified by the GIS equipment specialist team which needs to be addressed in the immediate future.

The Koeberg GIS bus duct system is based on the ABB (manufactures) GIS technology that was designed for very long busbars. The original equipment manufacturer (OEM) has since discontinued the use of GIL technology based egg insulators citing amongst other reasons; difficulty in fabricating the insulators, reliability concerns and difficulty to repair.

The installed 400/132 kV transformation at Koeberg Substation is 2 x 250 MVA. The load forecast indicates that the firm capacity of 250 MVA will be exceeded in the year 2022. There is also no space for additional 132 kV feeder bays at Koeberg Substation to accommodate future requirements for new lines.

It is for the aforementioned reasons that a new 400/132kV substation (Weskusfleur Substation) is proposed in the vicinity of the existing Koeberg Substation to:

- Improve the existing 400kV reliability
- Cater for load growth on the 132 kV network for the 20-year horizon.
- Prevent overloading of existing 400kV busbar
- Replace 30 year old technology/equipment

To improve the reliability of Koeberg MTS, several options were investigated and the option to build a new 2x250MVA, 400/132kV substation in the vicinity of the existing Koeberg GIS substation was the preferred one. The main activities may include:

- Build a new 2x250MVA; 400/132kV substation
- Construct the new 400kV busbar with space capability of 3x250MVA, 400/132kV transformation;
- Equip new 2x250MVA, 400/132kV transformers;
- Re-route the Gen transformers to the new 400kV busbar;
- Re-route the outgoing 400kV feeders; as follows-
  - Reroute Acacia-Koeberg 400kV Line 1
  - Reroute Acacia-Koeberg 400kV Line 2
  - Reroute Ankerlig-Koeberg 400kV Line 1
  - Reroute Ankerlig-Koeberg 400kV Line 2
  - Reroute Koeberg-Muldersvlei 400kV Line 1
  - Reroute Koeberg-Stikland 400kV Line 1
- Re-route the outgoing 132kV feeders; as follows-
  - Reroute Ankerlig-Koeberg 132kV Line 1 to accommodate new 2x500kV line servitudes of 45m each
  - Reroute Blaauwberg-Koeberg 132kV Line 1
  - Reroute Dassenberg-Koeberg 132kV Line 1
  - Reroute Dassenberg-Koeberg 132kV Line 2
  - Reroute Duine-Koeberg 132kV Line 1
- Divert the 400kV Ankerlig Sterrekus line around the yard’s position to minimize line crossings;
- Temporary storage of large volumes of transformer oil on site to be deposited into transformers;

- Temporary storage of any hazardous chemical substances to be used during the construction phase;
- The clearance of vegetation as a result of the construction of the substation and associated infrastructure;
- Decommissioning some of the existing substation infrastructure and lines.

It is important to note that the proposed Weskusfleur Subtation is a normal electricity transmission and distribution project and not associated to any nuclear related activities.

3.3 Electricity Transmission

3.3.1 Electrical power transmission and distribution

Electricity is generated as it is used. Unlike other commodities, there is very little ability to store electricity. Because of the instantaneous nature of the electric system, constant modifications must be made to assure that the generation of power matches the consumption of power. The South African electric system is very complex and dynamic, and needs to be adjusted to meet changing needs.

Electric power transmission is and a process in the delivery of electricity to consumers can be defined as the bulk transfer of electrical power. Typically, power transmission is between a Power Station and Substations that connect the national grid and end users.

Electricity is transmitted over long distances at high voltage along transmission powerlines from the Power Stations to the areas where it is needed. Electricity must be carried at high voltages (kilovolts, or kV) along transmission powerlines in order to make up for losses that occur over long distances, and to limit the number of power lines required. In order for the electricity to be transmitted safely and efficiently over long distances, it must be at a high voltage (pressure) and a low current (flow).

The voltages at which power is generated at the Power Stations are too low for transmission over long distances. To overcome this problem, transformers are installed at the power stations and substations to increase the voltage. Transformers step-up the voltage from, for example, 22kV to 220kV, 275kV, 400kV or 765 kV, and feed the electricity into Eskom’s national grid.

When the electricity arrives at a distribution Substation, bulk supplies of electricity are taken for primary distribution to towns and industrial areas, groups of villages, farms and similar concentrations of consumers. The lines are fed into intermediate Substations where transformers reduce (step-down) the voltage. This could be 11kV in large factories and 380/220 volts in shops and homes. Power is distributed to end-users via reticulation power lines (See **Figure 3.1**).

In South Africa, Eskom has a total of 32 342 km (as of January 2012) of high voltage transmission lines. All the high voltage lines, plus the transformers and related equipment, form the transmission system also known as the national grid.

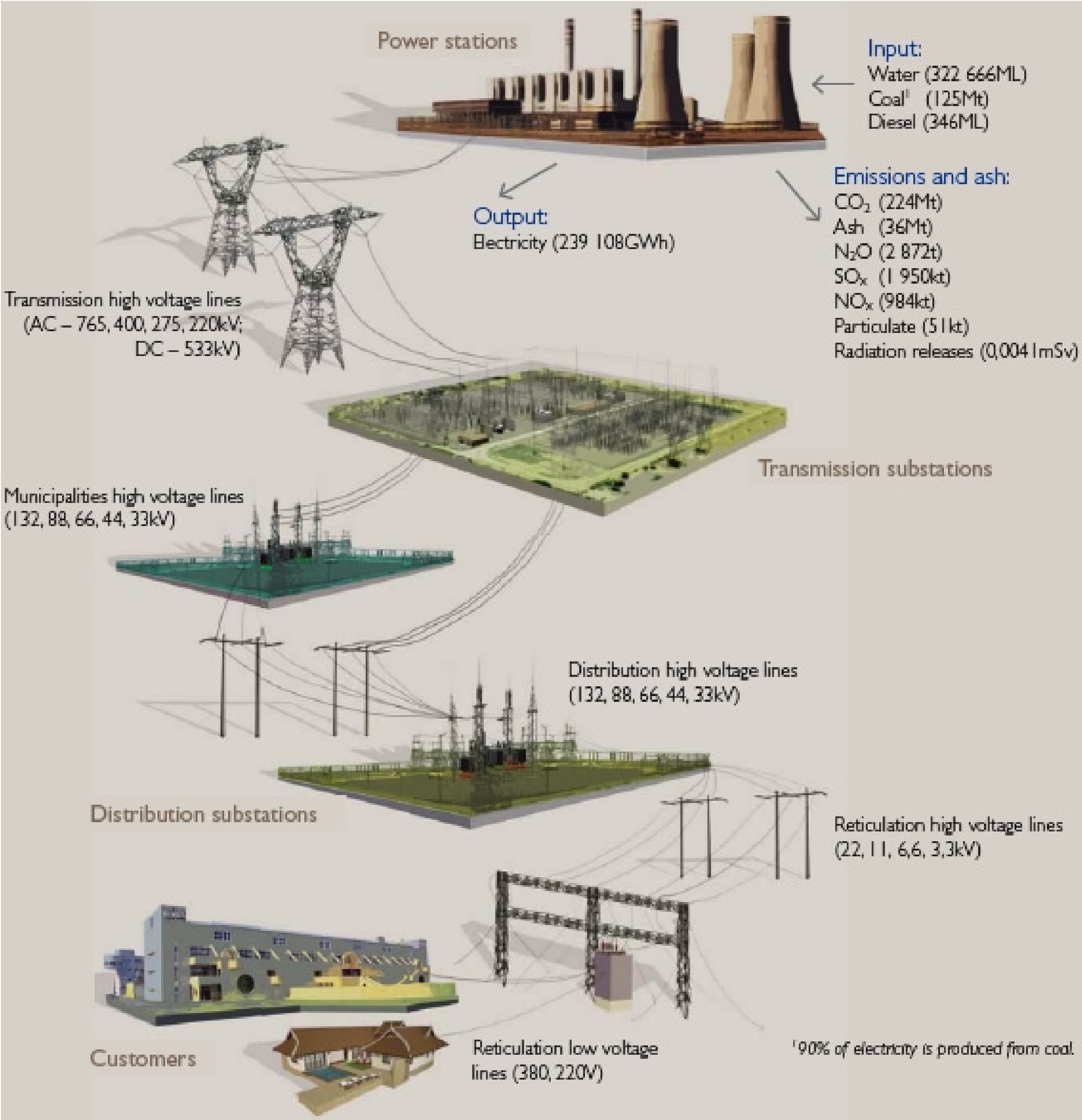

Figure 3.1 Simplified electrical transmission and distribution system (source: www.eskom.co.za)

3.3.2 Components of a typical transmission system

The main components of a typical electrical transmission system include the following:

- *Transmission towers*

  Transmission towers are the most visible component of the power transmission system. Their function is to inter alia, keep the high-voltage conductors (powerlines) separated from their surroundings and from each other. A variety of tower designs exist. Some tower designs reflect the specific function of the tower, while others have come about as a result of technological progress. Tower designs are discussed in Chapter 4 of this report; **Figure 3.2** below highlights two different tower designs.

Figure 3.2: Photograph of Self-supporting Strain tower (in foreground) and Cross Rope Suspension tower (in centre) designs**.**

- *Conductors*

Conductors are the powerlines that carry the electricity to and through the grid. Generally, several conductors per phase are strung from tower to tower. The number of conductors per phase depends on the design for the line, typically 3 to 4 conductors per phase. Conductors are constructed primarily of metal or other types of materials as appropriate. An example is illustrated in **Figure 3.3**.

Figure 3.3 : Photograph of conductors strung between transmission towers.

- *Substations*

  The very high voltages used for electric transmission are converted at **Substations** to lower voltages for consumer use. Substations vary in size and configuration but may cover several hectares; they are cleared of vegetation and typically surfaced with gravel. They are normally fenced, and are reached by a permanent access road. In general, substations include a variety of structures such as conductors, fencing, lighting, and other components (**Figure 3.4**).

Figure 3.4: Photograph of a Substation, which transforms electricity from high to low voltage for consumer use.

For the substation to perform it needs sophisticated protection equipment to detect faults and abnormal conditions. Action may consist for example, of automatically switching the power off and on again to cater for abnormal conditions such as lightning strikes or trees falling on lines. This action is necessary for safety reasons in the event of an accident or to keep the electricity supply constant.

- *Transformers*

  A **transformer** is basically a very simple device (**Figure 3.5**). The alternating current is led through a primary coil of wire, which produces an alternating magnetic field in the ring-shaped core of soft iron. This in turn creates a voltage in a secondary coil, from which the output current can be drawn. If the secondary coil has more turns than the primary coil, the output voltage is higher than the input voltage. This is a step-up transformer. A step-down transformer has more turns in the primary coil than in the secondary coil to reduce the voltage.

Figure 3.5: Transformers at a Substation.

3.4 Location of the Proposed Development

The study area falls within the City of Cape Town Metropolitan Municipality in the area adjacent to the existing Koeberg Nuclear Power Station (Koeberg) near Melkbosstrand, 30 km north of Cape Town on the West Coast. The area is bounded to the north by the West Coast District Municipality, to the north east by Cape Winelands District Municipality, to the south east by the Overberg District Municipality and to the south and west by the Atlantic Ocean. The regional location of the proposed project is indicated in **Figure 3.6**.

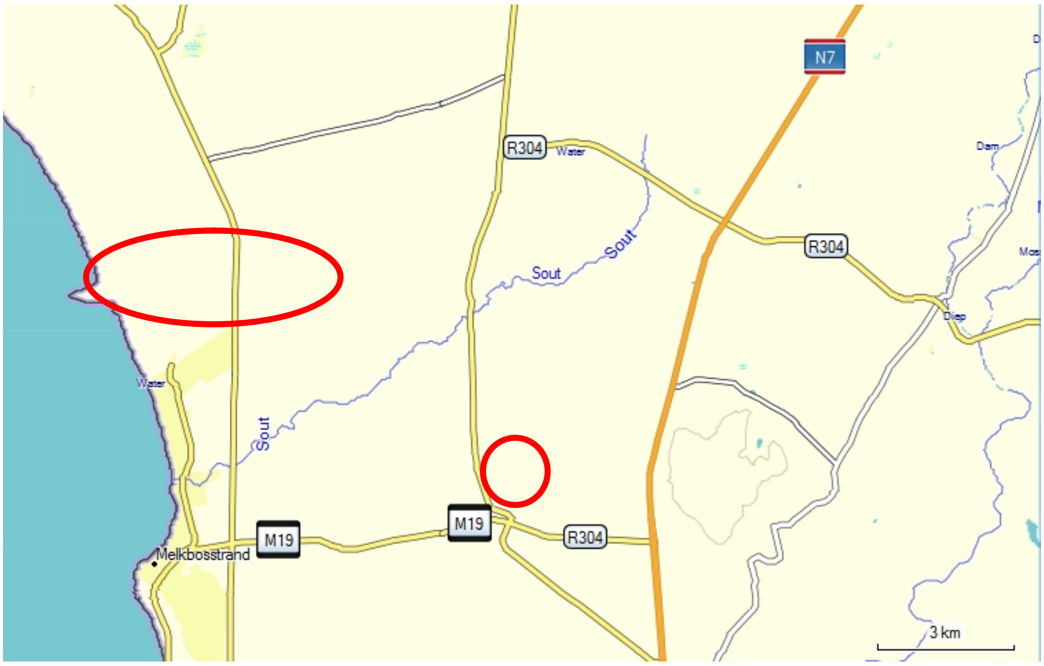

Figure 3.6: Locality of the Study Area within the City of Cape Town Metropolitan Municipal area of the Western Cape.

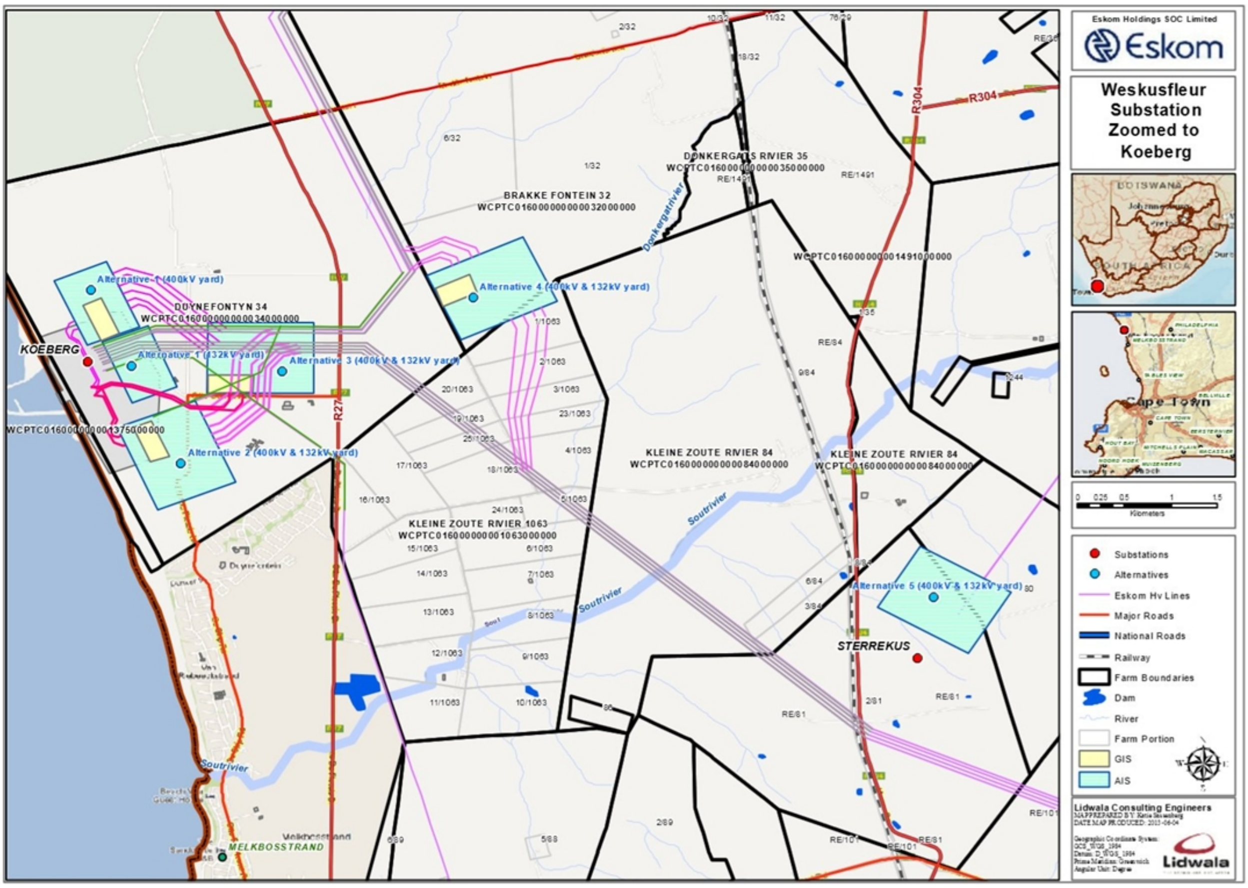

Figure 3.7: The 5 alternative sites within the study area (Note that the extent of the Air Insulated Substation (AIS) on the map is larger than required at 950 x 750 m, the actual required size is 760 x 550 m)

3.5 Detailed Description of the Project

The proposed project entails the construction of a new 400/132kV substation (Weskusfleur Substation) in the vicinity of the Koeberg Power Station to:

- Improve the existing 400kV reliability
- Cater for load growth on the 132 kV network for the 20-year horizon.
- Prevent overloading of existing 400kV busbar
- Replace 30 year old technology/equipment

The required area size for the substation location will be approximately 10 – 42ha depending on the final location and the type of technology used (Gas Insulated, GIS or Air Insulated, AIS) as per the outcomes of EIA process. The substation will need to account for the current and future needs/plans. The length of the diversion of the power lines will also be determined by the final substation's location.

The full scope of work includes:

- Build a new 2x250MVA; 400/132kV substation

- Construct the new 400kV busbar with space capability of 3x250MVA, 400/132kV transformation;
- Equip new 2x250MVA, 400/132kV transformers;
- Re-route the Gen transformers to the new 400kV busbar;
- Re-route the outgoing 400kV feeders; as follows-
  - Reroute Acacia-Koeberg 400kV Line 1
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  - Reroute Koeberg-Muldersvlei 400kV Line 1
  - Reroute Koeberg-Stikland 400kV Line 1
- Re-route the outgoing 132kV feeders; as follows-
  - Reroute Ankerlig-Koeberg 132kV Line 1 to accommodate new 2x500kV line servitudes of 45m each
  - Reroute Blaauwberg-Koeberg 132kV Line 1
  - Reroute Dassenberg-Koeberg 132kV Line 1
  - Reroute Dassenberg-Koeberg 132kV Line 2
  - Reroute Duine-Koeberg 132kV Line 1
- Divert the 400kV Ankerlig Sterrekus line around the yard's position to minimize line crossings;
- Temporary storage of large volumes of transformer oil on site to be deposited into transformers;
- Temporary storage of any hazardous chemical substances to be used during the construction phase;
- The clearance of vegetation as a result of the construction of the substation and associated infrastructure;
- Decommissioning some of the existing substation infrastructure and lines.

The proposed substation is a 2x250MVA; 400/132kV air insulated (AIS), substation. The system will be operated at 400kV and 132kV, however the 400kV yard will be insulated at 550kV and the 132kV yard will be insulated at 275kV levels. This is a requirement due to the high marine pollution in the area which requires higher insulation levels and the next range of standard equipment freely available to facilitate this is manufactured to the 550 and 275kV levels. Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) technology options is investigated which is described in Chapter 4.

A brief overview of the physical/technical requirements of the project is as follows:

Substation option	**Approx. Size (m)**	**Distance between gantries (m)**
400kV + 132kV AIS	760 x 550	75 (400kV) and 50 (132kV)
400kV + 132kV GIS	400 x 180	50 (400kV) and 40 (132kV)
Line size	Servitude width (m)	
400 / 500kV	45 - 55	
132kV	30	

The construction phase of the substation may entail the following:

- Construction of a access to the substation depending on the final location as per the outcomes of the EIA process
- Removal of all vegetation within the substation footprint
- Levelling of the site
- Installation of foundations for infrastructure such as transformers, control building and radio tower
- Construction of bunds and oil holding dams (for emergency holding of transformer oil) and fire safety walls
- Compaction and filling with gravel of the area between foundations
- Creation of formal drainage and stormwater control measurers
- Delivery and installation of transformers, towers, busbar and associated infrastructure
- Redirecting of existing 400kV and 132kV lines to enter and leave the substation
- Connection of the new infrastructure to the existing 400kV network
- Construction of perimeter fencing and lighting

3.6 Clearance requirements for transmission power lines

For safety reasons, the transmission power lines require certain minimum clearance distances. These are as follows:

- The minimum vertical clearance distance between the ground and the power lines is 5.5 m.
- The minimum vertical clearance to any fixed structure that does not form part of the power line is 10.4 m - 11 m.
- The minimum distance between a 400 kV power line and an existing road is 60 m – 120 m (depending on the type of road).

Any farming activity can be practiced under the conductors provided that safe working clearances and building restrictions are adhered to.

3.6.1 Use of services and resources during construction

- *Water*

Water will be required for potable use and in the construction of the foundations and other substation infrastructure. The water will be sourced from approved water use points at locations closest to the area of construction.

- *Sewage*

A negligible sewage flow is anticipated for the duration of the construction period. On site treatment will be undertaken through the use of chemical toilets. The toilets will be serviced periodically by the supplier.

- *Roads*

Existing roads will be utilised as far as possible during the construction and operational periods. The use of roads on landowner property is subject to the Environmental Management Plan (EMP) and will be determined based on discussions with landowners during the negotiation process.

- *Stormwater*

Stormwater will be managed according to applicable Eskom Guidelines for Erosion Control and Vegetation Management, as well as the Environmental Management Plan (EMP) that will be compiled for the construction phase.

- *Solid waste disposal*

All solid waste will be collected at a central location at each construction site and will be stored temporarily until removal to an appropriately permitted landfill site in the vicinity of the construction site.

- *Electricity*

If required, substation sites have electrical connections via the distribution grid. Diesel generators may also be utilised for the provision of electricity during construction.

3.7 The steps in constructing and operating a substation

The typical steps involved in the construction and operation of a transmission substation is summarised in **Table 3.2**.

Table 3.1: Typical steps in construction and operation of a substation and associated infrastructure

Step	Activity
1	Determination of technically feasible alternative sites
2	EIA of alternative sites and recommendation on most preferred site
3	Authority authorisation of site
4	Negotiation of final site alignment with landowners
5	Selection of best-suited foundations and structures
6	Final design of substation and placement of towers
7	Vegetation clearance and gate erection
8	Construction tender advertised and awarded
9	Establishment of construction camp and construction of access roads (if necessary)
10	Construction of substation
11	Rehabilitation of working areas and protection of erosion susceptible area
12	Testing and commissioning of substation
13	Ongoing maintenance

14	Decommissioning

3.7.1 Planning (Step 1)

The System Planning Department, as the system network planners, formulate a five-year, ten-year or twenty-year Transmission Development Plan (TDP), which is a strategic document aimed at identifying all infrastructure required throughout South Africa for the transmission of electricity. All projects initiated by these planners will have to be in line with the requirements stipulated in the TDP. All initiated projects are thoroughly investigated to ensure that they are both viable and feasible before being approved for implementation. Once approved, the Land and Rights Department initiates the process of the environmental impact assessment (EIA).

3.7.2 Environmental impact assessment and authority authorisation of site (Step 2 and 3)

The EIA process forms part of the scope definition stage of a project. The aim of this process is to identify the possible site where the project can be implemented with the minimal impact on the environment.

The actual location of the new substation is determined by a number of factors, including Eskom negotiation with landowners, environmental features and technical requirements. As a result of these factors, it is impossible to predict the exact location of the substation within the EIA process. The inherent variation that is likely in the final placement of the substation is factored into the EIA through the assessment of alternative sites.

A final EIR is produced and provided to the DEA with all the alternative sites assessed during the EIA process. Recommendations for the least impacted site/s are provided for consideration during authorisation. The DEA will issue an environmental authorisation based on the information provided.

A project-specific Environmental Management Plan (EMP) is drafted for the project and this document details the specific controls which must be in place for the duration of the construction phase. An Environmental Control Officer (ECO) who acts as an intermediary between individual landowners, Eskom and the contractors, implements the EMP.

3.7.3 Negotiation of final site alignment with landowners (Step 4)

This step depends on the final location as per the outcomes of the EIA process as certain alternatives are on Eskom owned land and other on private property.

Registration of servitude can be a lengthy process, as it requires contractual negotiation with each affected landowners. Once this is complete, an application for registration of the servitude is lodged with the Registrar of Deeds to register the rights. Once Eskom exercises the option granted by the landowner, construction can commence. Sometimes construction starts before servitudes are registered at the Deeds office. For this reason

Eskom pays the landowner a simple interest as determined by the Minister of Finance from the date of option to the date of registration. The servitudes do not imply that the holder of the servitude (Eskom) is the owner of the land but merely that the holder has a right to convey electricity over that land, subject to certain provisions.

3.7.4 Selection of best-suited foundations and structures (Steps 5 – 7)

The topographical profile and plans are used by the design engineers to design the foundations, structures, buildings, etc. All the above information would be required by the contractor before commencing construction.

3.7.5 Construction (Steps 8 – 10)

The final EMP will only be completed when all the profiles and site plans are available. This EMP will outline all activities that have to be undertaken, where they will take place, the responsible person/s, all possible environmental or social impacts, the mitigating measures, the rehabilitation plans, the monitoring methods, the frequency of monitoring and the performance indicators. This is a legally binding document which is used to ensure that Eskom adheres to all conditions of the Environmental Authorisation and EIR. Once this document has been approved by an authorised statutory body, the appointed contractor can commence construction.

3.7.6 Rehabilitation (Step 11)

After the project has been completed, all affected properties are rehabilitated to as close to their original status as possible. Landowners sign off release forms to confirm the rehabilitated status.

3.8 Commissioning of the substation and on-going maintenance (Steps 12 - 13)

Eskom technicians will test and commission the substation once all the above steps have been completed. Maintenance of the substation and the associated infrastructure and surrounding servitude will take place on an on-going basis, as per the finalised operational EMP. Regular monitoring will also take place to ensure that this EMP is complied with effectively, and penalties will be enforced for non-compliance.

3.9 Decommissioning (Steps 14)

The decommissioning of some of the substation infrastructure and lines is investigated as part of this project. The EMP will outline all activities that have to be undertaken, where they will take place, the responsible person/s, all possible environmental or social impacts, the mitigating measures, the rehabilitation plans, the monitoring methods, the frequency of monitoring and the performance indicators in terms of proposed decommissioning.

3.10 Conclusion

This chapter provides a description of the proposed development and describes the various components of an electrical transmission system, namely; transmission towers, conductors, substations and transformers. This chapter further discusses the various associated infrastructure and the need for certain services and resources during construction. Finally, the various steps in constructing and operating a substation are discussed and illustrated.