DESCRIPTION OF THE GOURIKWA POWER STATION & TRANSMISSION INTEGRATION PROJECT CHAPTER 3

This chapter provides details regarding the scope of the proposed Gourikwa Power Station and Transmission Integration Project, including all required elements of the project and necessary steps for the project to proceed. The scope of project includes construction and operation activities. The expected lifespan of the project is approximately 25 years, with the option to extend this lifespan at the end of this period through the replacement of components, should this be required. Decommissioning of the infrastructure is therefore considered as an activity which is unlikely to occur in the short- to medium-term.

3.1. Power Station Conversion

The existing Gourikwa OCGT Power Station consists of five OCGT units (i.e. three existing OCGT units, plus two additional five OCGT units, currently under construction) each with a nominal capacity of ~150 MW, resulting in a total nominal capacity of 750 MW for the power station. Each OCGT unit consists of one gas turbine driving an electric generator.

The concept of converting the OCGT units to CCGT units is to utilise the **heat energy** from the exhaust of the gas turbine to create steam in a Heat Recovery Steam Generator (HRSG) in order to drive a steam turbine, instead of this heat energy being exhausted and lost to the atmosphere (as is the current scenario). Conversion of the units to CCGT is therefore based on increased cycle efficiency.

Simply stated, this can be achieved through the following (and is illustrated in Figure 1.2):

» When the hot gas exits the gas turbine as exhaust gas, it has a temperature of up to 600°C. This heat energy is transferred to water in the heat recovery steam generator, instead of being exhausted to the atmosphere.
» The heat is used to generate steam (water vapour), which powers the steam turbine to produce mechanical energy.
» The resulting mechanical energy is transferred to a generator, where it is converted into electricity (i.e. electrical energy).
» A condenser converts exhaust steam from the steam turbine back into saturated water through a cooling process.

Conversion of the units to CCGT is undertaken to increase cycle thermal efficiency. It is estimated that each converted unit will produce approximately 80 MW additional capacity, i.e. approximately 50% more than a standard OCGT unit. Therefore, a maximum of an additional 5 x 80 MW (400 MW in total) increase in capacity is foreseen from the OCGT to CCGT conversion. The **total nominal capacity** of the Gourikwa Power Station following the conversion to CCGT will, therefore, be **1 150 MW**.

The proposed conversion infrastructure will be on the site of the existing Gourikwa Power Station, and will not require any additional land take outside of the existing power station boundaries. Therefore, no location alternatives have been considered within this EIA process.

The primary components of the conversion project include the following:

» A **heat recovery steam generator** (HRSG) will be added to the gas turbine to recover waste heat, to drive the steam turbine cycle. One HRSG can be linked to two or three OCGT units. The following configuration is currently being investigated from a technical perspective:
  * A configuration of 1 x 3:1 (OCGT: HRSG units),
  * A configuration of 1 x 2:1 (OCGT: HRSG units)
» A **condenser** which converts exhaust steam from the steam turbine back into water through a cooling process.
» A **bypass stack** for the CCGT, anticipated to be approximately 60 m in height, will be associated with each HRSG. It is anticipated that two bypass stacks will be required (depending on the configuration of OCGT:HRSG).
» **Water treatment plant** for treatment of potable water and production of demineralised water (for steam generation).
» **Dry-cooled technology** consisting of a system of air-cooled condenser fans situated in fan banks approximately between 25 m - 30 m above ground.
» A **water pipeline** between the PetroSA facility and the Gourikwa Power Station, proposed parallel to the existing diesel pipeline.
» A **water tank** with a holding volume of ~2.5 million litres (i.e. water storage for ~5 days of operation).
» A **gas pipeline** between the PetroSA facility and the Gourikwa Power Station, proposed parallel to the existing diesel pipeline between the two facilities. The CCGT units can be both liquid fuel-fired (diesel) or natural gas-fired. The CCGT units would initially be diesel-fired, until such time that natural gas becomes available for use.

Comment: All reference to additional fuel storage tank has now been removed, as per Reggie's confirmation that they will no longer be required. Do we need a sentence in somewhere to say why, as someone may wonder why we are no longer considering them.

Water will be required for the CCGT power generation process and for cooling. High quality water is required for use within the CCGT power generation process. Membranes/ion exchange systems would be required for water treatment on site. A waste treatment plant for the effluent from this water treatment system will be required. All solid waste generated from this process would be disposed of off-site at a suitably licensed waste disposal facility.

The power station is to be operated as a zero liquid effluent discharge (ZLED) system, i.e. water within the power station will be recycled for re-use in the power station process. No liquid waste from the power station will therefore be discharged to the environment.

3.1.1. Investigation of Water Resource Options

Process water will be required for the CCGT power generation process, as well as water for cooling. It is estimated that approximately 300 m^3/day will be required for this purpose.

In order to meet this demand, the feasibility and availability of various water resource options were investigated by Eskom in terms of technical, economic and sustainability criteria. The water resource options have considered an assurance level of 98% and take into account an on-site storage of 5 days. These options included

a) the use of the use of treated water, effluent and/or stormwater from the PetroSA facility adjacent to Gourikwa;
b) the use of water from the Hartebeeskuil Dam situated approximately 7 km from Gourikwa; and
c) the use of treated industrial effluent from the Hartenbos Sewage Works situated approximately 13 km from Gourikwa.

From the results of the preliminary investigations, the options of using treated water, effluent and/or stormwater from the PetroSA facility are considered the most practical and viable, and have been nominated as the preferred option/s in the short-term based on technical, environmental and economic constraints. These options are currently being jointly further investigated by Eskom and PetroSA. These options are being investigated to ensure their viability and sustainability. A preferred option will be nominated with the agreement of PetroSA for implementation based on technical, environmental and economic constraints[6].

The water will be piped to the power station from PetroSA via a new **~1,3 km water pipeline** proposed to be constructed parallel to the existing liquid fuel pipeline between the two facilities. Alternative routes for the fuel pipeline were previously investigated through an EIA process for the initial OCGT units at the power station (Ninham Shand, 2005). The fuel pipeline route constructed was considered to be the most appropriate and practical alignment from an environmental, technical and economic perspective. This alignment is now

[6] These options are the subject of a separate investigation being undertaken by Eskom together with PetroSA.

proposed to be mirrored though the construction of a parallel water pipeline. Therefore, no alternative alignments have been considered within this EIA process. This water pipeline would be outside of the existing power station boundaries. The water pipeline would be constructed above ground, and would require a servitude width of ~5 m.

3.1.2. Investigation of Cooling Technologies

A number of cooling technology options for the CCGT have been investigated by Eskom, including dry-cooled technology and wet-cooled technology. Due to financial and technical constraints, **dry-cooling technology (air-cooled condensers)** has been nominated as a preferred option for implementation. Dry-cooling technology is less water-intensive (i.e. uses significantly less water) than wet-cooled technology, and consists of a system of air-cooled condenser fans situated in fan banks approximately 25 m – 30 m above ground. In a direct dry-cooled system, the steam is condensed directly by air in a heat exchanger (air cooled condenser) and the condensate is returned to the steam cycle in a closed loop. The air flow is induced solely by mechanical draft (i.e. caused by fans) in the air cooled condensers.

A condenser converts exhaust steam from the steam turbine back into saturated water through a cooling process. This water (condensate) is then fed into a Condensate Polishing Plant (CPP) to treat/polish it to desired qualities, before it is fed back into the HRSG as part of the steam cycle. Regeneration wastes, a highly saline effluent from the CPP, will be required to be disposed of. Eskom is currently investigating various disposal options (one of which could be on-site wastewater treatment).

3.1.3. Fuel Alternatives

Conversion of the units to CCGT is based on **increased cycle thermal efficiency**. The CCGT units would utilise the **same amount of liquid fuel** (i.e. diesel) as is currently the case for the OCGT units (i.e. approximately 40 tons of diesel/unit/hour) for the same operating regime. However, in order to meet the electricity supply demand in the medium-term, the plant will have to operate for more hours per day than was anticipated for the OCGT plant (i.e. higher than anticipated load factors). Therefore, the power station will not only operate as a peaking power plant[7] as is currently the case, but will contribute to the mid-merit electricity generation supply[8].

[7] Peaking power refers to power generation technology designed to generate electricity during periods of high electricity demand, generally in the weekday mornings from 07:00 to 09:00 and weekday evenings from 18:00 to 20:00.
[8] Mid-merit capacity is during the daytime from about 6 am to about 10 pm on weekdays.

This **higher load factor** would require **higher fuel consumption**. Should liquid fuel be utilised as a fuel source (as is currently the case) additional fuel storage facilities would be required at the Gourikwa Power Station to cater for the increased fuel requirements associated with the higher load factor. Fuel is currently transported by pipeline to the Gourikwa Power Station site directly from the fuel supply point at PetroSA. This liquid fuel pipeline to the power station would continue to be used with the conversion project.

Eskom currently has authorisation to store 10,8 million litres of fuel on the Gourikwa Power Station site (i.e. four tanks of 2 700 m^3 capacity each). In order ensure supply of fuel to the CCGT units at the higher load factor, Eskom would require the storage of an additional 32,4 million litres of fuel on the power station site (i.e. six tanks of 5 400 m^3 capacity each), resulting in a total storage capacity of 43,2 million litres on site. An area to the west of the power station expansion has been earmarked for this additional fuel storage (refer to Figure 3.1). Provision would be required to be made for 6 x 5 400 m^3 fuel storage tanks, as well as associated infrastructure. Security of liquid fuel supply nationally is regulated by the Department of Minerals and Energy (DME)[9].

The OCGT units at the power station are currently fuelled using diesel, which is supplied by the PetroSA facility. The use of diesel as a fuel source following the conversion of the units is considered by Eskom to be a potential economic constraint, as more fuel would be required to operate the power station at a higher load factor (i.e. longer operating hours or a mid-merit operating regime[10]). Therefore, Eskom are currently investigating the opportunities to include natural gas as an option for a fuel source at the Gourikwa Power Station. This natural gas supply is also proposed to be sourced from the adjacent PetroSA facility[11] and conveyed to the power station via a pipeline. This pipeline is proposed to be constructed parallel to the existing diesel and proposed water pipelines between the two facilities. The gas would be fed directly into the gas units from the pipeline. The proposed pipeline would be approximately 1,3 km in length and would be constructed outside of the power station boundaries.

Comment: Please confirm

3.1.4. Direct Access Road to the Gourikwa Power Station site

Eskom propose the construction of a new dedicated **access road** to the Gourikwa Power Station directly off the N2 national road. The power station currently shares an access road with PetroSA, which is not considered desirable from a safety and accessibility perspective in the long-term, as both the PetroSA as well

[9] Refer to Energy Security Master Plan – Liquid Fuels, published by the DME.

[10] Mid-merit capacity is during the daytime from about 6 am to about 10 pm on weekdays.

[11] The availability of natural gas for use at Gourikwa Power Station is the subject of a separate investigation being undertaken by Eskom together with PetroSA. A separate EIA process is currently being undertaken in this regard.

as the Gourikwa Power Station are considered to be National Key Points in their own right.

Alternative routes for access to the power station were previously investigated through an EIA process undertaken in 2005 (Ninham Shand, 2005). The route considered to be the most appropriate and practical alignment of the three alternatives considered in the previous EIA is now being re-considered through this EIA study. Therefore, no alternative alignments are being considered within this EIA process. The route was not previously constructed as it was agreed to share the use of the existing PetroSA access point.

The proposed new access road route is approximately 1,6 km in length, and would be outside of the existing power station boundaries. This route takes access from the N2 approximately 2,5 km west of PetroSA's western-most security access road (to the landfill site) and runs in a north-easterly direction along the western boundary of the PetroSA property (refer to Figure 3.2). The proposed new road follows an existing fence line for much of its length. The access road would be constructed as a single carriageway surfaced road and would require a servitude width of approximately 15 m. A new formal access point (or intersection) would be required from the N2, and will be required to be negotiated with the South African National Roads Agency (SANRAL) and designed and constructed to their specifications.

Figure 3.1: Aerial photograph of the Gourikwa Power Station site showing the existing power station infrastructure, the expansion site, as well as the areas for the placement of infrastructure associated with the proposed conversion

Comment: To be inserted

Figure 3.2: Map illustrating the proposed new access road route from the N2 in a north-easterly direction along the western boundary of the PetroSA property

Comment: To be inserted

3.1.5. Project Construction Phase

It is expected that the construction of the power station conversion would commence in late-2009, and would take a maximum of 24 months to complete, with commissioning of the first unit estimated at the end of 2011. In order to meet the urgent need for additional electricity generation capacity, Eskom would aim to fast-track this construction timeframe as far as possible.

Comment: Please confirm

The number of construction workers required for a project of this nature is still being determined. Construction crews will constitute mainly skilled and semi-skilled workers. No employees will reside on the construction site at any time during the construction phase, and the intention is for appropriate accommodation to be sought and provided within the nearby residential area.

3.1.6. Project Operation Phase

The project is proposed to be implemented by 2011, with the commissioning of the first unit estimated at the end of 2011.

As is typical of gas turbine power stations, the expected lifespan of the power station is approximately 25 years, with the option to extend this lifespan at the end of this period through the replacement of components, should this be required. The creation of additional employment opportunities during the operational phase of the power station will be limited. It is estimated that the project will support only about 20 direct employment opportunities (operators/maintainers).

3.2. Integration of the CCGT Power Station into the National Grid

Eskom proposes the construction of a 400kV transmission power line between the Gourikwa Power Station and the existing Proteus Substation to transmit the additional power generated at this power station to the national electricity grid. Proteus Substation is situated approximately 10 km north-west of the power station adjacent to the R327 main road.

The proposed conversion project considers the addition of 400 MW of power generation at Gourikwa Power Station. The Transmission Grid Code requires a minimum of three lines for generation integration greater than 1 000 MW (the total nominal capacity of the Gourikwa Power Station will be 1 150 MW with the conversion). Currently two 400kV transmission power lines integrate Gourikwa Power Station into the 400kV network at Proteus Substation. A third 400kV transmission power line is therefore required to be constructed as part of the proposed conversion project.

Two new generator transformer bays will be required within the existing Gourikwa Substation high voltage (HV) yard to accommodate the additional 400 MW generation capacity and connect the new capacity into the greater 400kV network. In order to accommodate the new power line at the Proteus Substation, a busbar extension will be required (refer to Figure 3.3). This will involve terrace work within the existing substation boundary.

Comment: This is different to the info which Tx provide to us at Scoping phase – so this is not mentioned in the Scoping Report.

Two technically feasible alternative transmission power line alignment corridors (approximately 500 m in width) have been identified for investigation within the EIA process (refer to Figure 3.4).

Alternative 2 (indicated in red on Figure 3.4) runs parallel to the two existing Gourikwa-Proteus 400kV transmission power lines (Gourikwa-Proteus 1 and 2) for the entire length of its alignment (approximately 10 km).

Alternative 3 (indicated in blue on Figure 3.4) runs parallel to the two existing Mossgas-Proteus 132kV distribution power lines (Mossgas-Proteus 1 and 2) for the entire length of its alignment (approximately 10 km).

Figure 3.4: Locality map showing the feasible alternative transmission power line corridor alternatives between Gourikwa and Proteus Substation identified for investigation within the EIA process

Through the EIA process, a preferred alternative transmission power line corridor will be nominated for environmental authorisation (by the environmental authorities), provided no environmental fatal flaws are identified to be associated with the proposed project.

Transmission power lines are constructed and operated within a servitude (55 m wide for 400kV lines) that is established along the entire length of the line. Within this servitude, Eskom has certain rights and controls that support the safe and effective operation of the line. The process of achieving the servitude agreement is referred to as the Servitude Negotiation Process with each affected landowner. The negotiation process is undertaken directly by Eskom and is independent of the EIA process.

While there should be reasonable confidence in the environmental feasibility of the preferred corridor nominated, other criteria may require minor alteration to the final alignment within the corridor which received environmental authorisation during the land negotiation process undertaken by Eskom. These may include:

» Identification of a technical problem during the detailed design phase which will require excessive cost to resolve (e.g. unstable subsurface conditions identified by detailed geotechnical investigations).
» Request by a landowner during the course of the negotiation process that the alignment be shifted to avoid disruption of a particular activity on his property, but provide a feasible new alignment.

Provided such potential deviations are not unreasonable, it is fair for Eskom Transmission to investigate and negotiate local adjustments within the authorised corridor alignment. This may be required at a number of points along the alignment.

3.2.1. Project Construction Phase

It is expected that the construction for transmission power line will commence in 2009, and would take approximately 9 months to complete. In order to meet the urgent need for additional electricity generation capacity, Eskom would aim to fast-track this construction timeframe as far as possible.

Comment: Please confirm

Construction crews will constitute mainly skilled and semi-skilled workers. No employees will reside on the construction site at any time during the construction phase.

3.2.2. Project Operation Phase

The Transmission integration would be required to be operational prior to the Gourikwa Power Station conversion being implemented in 2011.

The expected lifespan of the proposed transmission power line is between 35 and 40 years, depending on the maintenance undertaken on the power line structures. The creation of additional employment opportunities during the operational phase of the power line will be limited, and will be restricted to skilled maintenance personnel employed by Eskom.