ORANGE RIVER SCHEME – GARIEP AND VANDERKLOOF POWER STATIONS

The Orange River Scheme is one of South Africa's most ambitious engineering projects undertaken to provide a solution to chronic water shortages and to generate hydro-electricity.

Generating Electricity
Eskom Holdings Ltd provides 95% of the electricity in the Republic of South Africa and is among the largest producers of electricity in the world. South Africa is rich in coal and 90% of Eskom's electricity is produced by coal fired thermal power stations. Water resources are at a premium in South Africa and the two power stations on the Orange River are the only conventional hydro-electric schemes of significance in the country.

Gariep and Vanderkloof Power Stations are situated in South Africa's Eastern and Northern Cape Provinces respectively. They are built adjacent to the Gariep and Vanderkloof Dams, on the Orange River, in the country's summer rainfall region.

Gariep and Vanderkloof Power Stations are owned by Eskom Holdings Ltd and operated by Peaking Generation, part of the Generation Division of Eskom Holdings Ltd. Their electricity feeds into the Eskom National Grid to supply power for peak and emergency demand periods, as well as base load energy when excess water might pose a flood risk.

The Dams
The Gariep and Vanderkloof Dams are the largest and second largest water reservoirs respectively in the Republic. Vanderkloof is situated 130 km downstream of Gariep. These dams (owned and operated by the Government Department of Water and Environmental Affairs) and the Eskom hydro power stations, are integral components of the Orange River Scheme.

There is a close liaison and co-operation between DW&EA and Eskom. This ensures that in a water-scarce South Africa provision is made for irrigation, urban water supplies, recreation and the generation of electricity.

Due to the multi-purpose nature of the Orange River Scheme as a whole, a balance has to be maintained with regard to water resources for irrigation etc and water available for power generating purposes. Eskom contributed to the cost of raising the walls of both Gariep and Vanderkloof Dams in order to substantially increase the hydro power potential of the dams.

Operation and maintenance of the Power Stations
Outstanding operating and maintenance processes have resulted in decades of excellent plant performance. The pro-active development of technical plans for current maintenance, future refurbishment and capacity upgrades, as well as the focus on long term plant health, will ensure that these environmentally friendly hydro plants continue to deliver electricity for decades to come.

1. **Resource use:**
   South Africa is affected by wet and dry climatic cycles. These affect the river flow to the dams that in turn influences the availability of water to the power plant. For optimum management of this precious water resource for both power generating and water supply purposes, a sophisticated operating model has been developed by Eskom and DW&EA. Set control curves are used to maximise the generation of electricity without violating the rights of downstream users.

   The stations produce base load energy during times of flood risk to prevent the dams from spilling water and to take advantage of an opportunity for low cost energy production.

   The innovation of running a Gariep unit for one hour every three hours allows water release for downstream users while deriving energy that would otherwise have been wasted.

2. Energy system benefits:

The hydro power plants are peaking power stations and provide a swift response to the needs of the South African energy market. Ancillary services such as governing (frequency control), and synchronous condenser operation to control network stability and voltage are also provided. The units are able to come on line within three minutes and can thus be relied upon for a swift reaction to emergency demands and to contribute to grid stability.

3. Cost benefits and economic performance:

The electricity produced by the Orange River Hydro stations would otherwise have to be sourced from Eskom's thermal power stations at double the cost.

4. Environmental aspects:

All environmental aspects were considered during the planning and construction phases of the power stations, and these continue to be monitored during the operational phase. Ongoing management reviews ensure compliance with international, company and national legislative requirements and include water quality, erosion and social aspects of the sites' operations.

Both power stations are fully compliant with the ISO 14001 Standard for Environmental Management Systems and comply with all relevant national environmental and water management legislative requirements.

In line with international agreements, the South African Government is committed to 4% of estimated electricity demand being met by renewable energy resources, such as the Orange River Hydros, by 2013.

In coal rich South Africa, the hydros displace a portion of the electricity, which would otherwise be generated by Eskom's fossil stations. The approximately 700 GWh generated annually by the hydros results in about 200 000 fewer kilogrammes of particulate matter being emitted into the air.

5. Safety:

The safety of personnel, the public and plant is of paramount importance and a culture of safety awareness has been inculcated into every activity on these sites. Gariep and Vanderkloof comply with Eskom's stringent Health and Safety Policies as well as the National Occupational Health and Safety Act, with external and internal audits being carried out on an ongoing basis.

Technical data

Dams

	Gariep	***Vanderkloof***
Type	Double curvature concrete arch	Double curvature concrete arch
Maximum height above foundations	90,5m	108m
Crest length	947,9m	770m
Volume of excavation	2,1 million m^3	2,43 million m^3
Volume of concrete placed	1,73 million m^3	1,116 million m^3
Storage volume	5 670 million m^3	3 236 million m^3

Power Stations

	Gariep	***Vanderkloof***
Type	Surface	Underground
Number of machines	4	2
Full load capacity per machine	90MW	120MW
Full load station capacity	360MW	240MW
Hydraulic turbine		
- Type	Vertical Francis	Vertical Francis
- Design net head	55 m	61 m

- Rated speed	136,4 rpm	125 rpm
- Maximum water consumption	220 m^3/s	217 m^3/s
- Runner diameter	4,88 m	5,30 m
- Runner mass	53 tons	53,7 tons
- Runner material	Cast stainless steel	Cast stainless steel
- Inlet diameter of spiral casing	5,5 m	7,0 m

Generator		
- Type	Umbrella	Umbrella
- Rated output	100MVA at 0,9 power factor	133MVA at 0,9 power factor
- Rotor diameter	8,9 m	9,5 m
- Mass of rotor	380 tons	436 tons
- Nominal voltage	13,2 kV	11 kV
- Thrust-bearing load	9 MN	14 MN
- Transformer voltage	13,2/132 kV	11/220 kV
Construction commenced	December 1967	January 1973
Commissioning Set 1	September 1971	December 1976
Set 2	November 1971	February 1977
Set 3	January 1976	-
Set 4	February 1977	-

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