PUMPED STORAGE HYDROELECTRIC SCHEMES AND WATER TRANSFER

Water resources are at a premium in South Africa and the Drakensberg and Palmiet Pumped Storage Schemes play an unusual dual role in making optimum use of this scarce resource. The two pumped storage schemes are joint ventures between Eskom and the Department of Water Affairs (DWA). Not only do they generate hydroelectric peaking power for the Eskom national grid, their reversible pump/turbines are components of inter-catchment water transfers.

Conventional hydroelectric power stations

In conventional hydroelectric power stations, the potential energy of water stored in a dam or river is converted into electrical energy. Water is conveyed through waterways to hydro-turbines. The water flowing through the turbine runner spins the turbine shaft, thus driving the rotor to which it is coupled. The electricity generated is fed onto the transmission lines that link up with the electricity grid. Once the water has run through the turbines it is discharged back into the river below the power station to continue its course.

In countries where water resources are plentiful, hydroelectric power stations can be run continuously to provide 24-hour base load electricity. Electricity generated by conventional hydroelectric power stations is cheaper than that produced by coal-fired power stations. In addition, where the latter consume the coal used in electricity generation, the former do not consume the water, but merely utilise its energy. Running costs are consequently much lower.

These power stations also have the advantage of being able to start up very quickly and are thus frequently used as peaking power stations. Their quick reaction time enables them to respond swiftly to sudden changes in consumer demand and emergencies. They also lend themselves to automation and can be operated by remote control. For example, the hydroelectric power stations on the Orange River are operated by remote control from Eskom's National Control Centre in Germiston.

However, because of South Africa's limited water resources and erratic rainfall it is not feasible to make greater use of conventional hydroelectricity.

Pumped storage power stations

In water scarce areas, pumped storage schemes are used as an alternative to conventional hydroelectric power stations to provide the power needed during peak periods. Instead of the water being discharged, it is retained in the system and re-used.

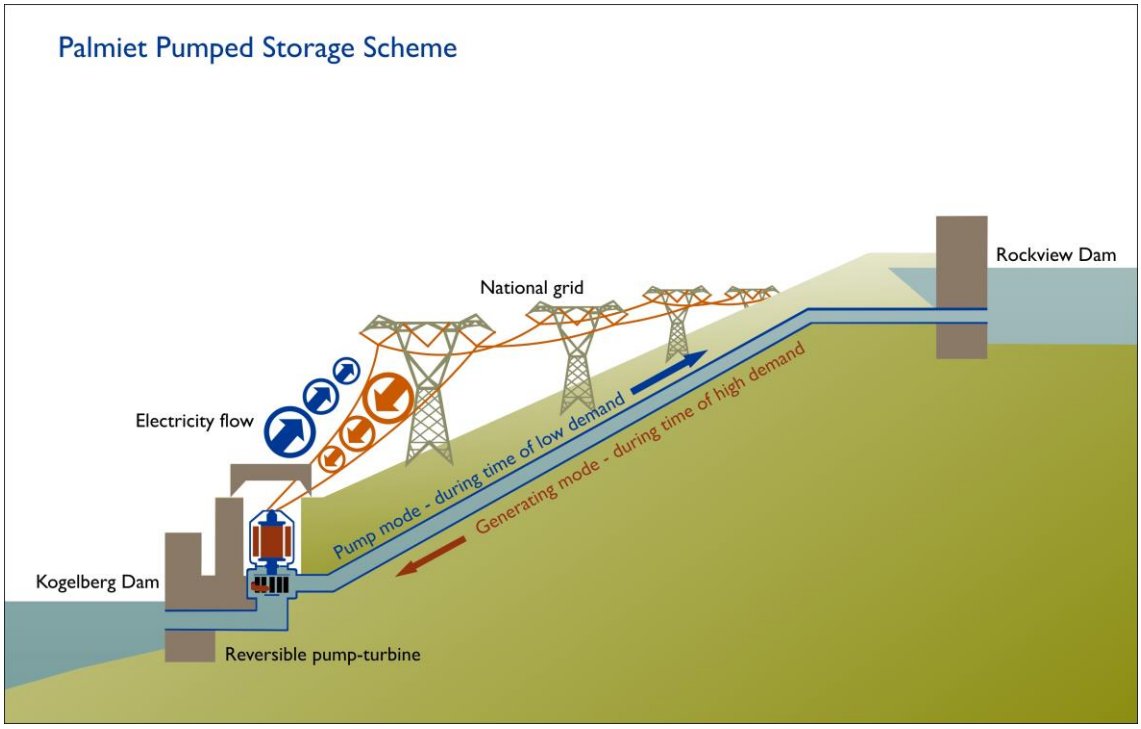
A pumped storage scheme consists of lower and upper reservoirs with a power station/pumping plant between the two. During off-peak periods, when customer demand for electricity has decreased, the reversible pump/turbines use electricity from the national grid to pump water from the lower to the upper reservoir. During periods of emergency or peak demand, this water is allowed to run back into the lower reservoir through the turbines to generate electricity. In this way, the potential energy of water stored in the upper reservoir is released and converted into electricity when needed.

Because it is necessary to pump the water back after use, pumped storage power stations can only provide energy for limited periods of time. In addition they are more expensive to operate than conventional hydroelectric power stations because of their pumping costs.

These disadvantages are offset by their quick re-action to changes in electricity demand which play a major part in maintaining the stability of the Eskom national grid.

Hydroelectric and pumped storage, rather than coal-fired, power stations are preferred as "peaking" power stations. They can be brought on-stream within three minutes, whereas a coal-fired power station requires several hours from cold start before it can start generating power.

Pumped storage operation



Inter-catchment water transfer
A water transfer scheme diverts water from one river system to another. It is undertaken when the potential use of water in one system is insufficiently developed or alternatively where it is not required. In such cases the water would flow unused to the sea and in practical terms, be lost. Transferred to another river system however, this water can be used for irrigation, domestic and industrial water supplies and power generation.

The Department of Water Affairs is responsible for South Africa's water resources. Joint ventures between DWA and Eskom resulted in the construction and operation of the Drakensberg and Palmiet Pumped Storage Schemes. In both cases, the powerful pump/turbines installed in the power station are used to pump water up to an elevation from which it can be transferred into a different river catchment.

Eskom's pumped storage schemes
The Drakensberg Pumped Storage Scheme generates electricity during peak periods in its role as a power station, but also functions as a pump station in the Tugela-Vaal Water Transfer Scheme. Water is pumped from the Thukela River, over the Drakensberg escarpment into the Wilge River, a tributary of the Vaal. The scheme was commissioned in 1982 and has a generating capability of 1 000MW.

The Palmiet Pumped Storage Scheme transfers water from the Palmiet River catchment into the Steenbras Dam to supplement Cape Town's water supply. The power station can generate 400MW during peak demand periods and began commercial operation in 1988.

Ingula is Eskom's third pumped storage scheme and is purely used for power generation during peak demand. It is situated 55km from Ladysmith (20km northeast of Van Reenen's Pass), within the Drakensberg range, on the border between the Free State and KwaZulu-Natal. The 1 332MW station is fully operational, with the last of its four units going live on 30 January 2017.

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