

Using pumps to generate electricity

A forward-thinking municipal technical team serving the requirements of the Drakenstein Municipality (Wellington) in the Western Cape has designed one of the country's largest pump and turbine stations, which will be used for pumping water to the nearby town of Paarl during dry periods; and to generate electricity for the city during the remainder of the year.

Drakenstein Municipality's city's engineer for water operations, Hein Henning, says the city was faced with the dilemma of having to pump water to its neighbouring town, Paarl, for just one month a year. For the rest of the year the pump station would be dormant, while still needing hundreds of thousands of rands in maintenance to prevent corrosion, perishing, and lubrication and bearing damage to the idle infrastructure.

Instead, the progressive municipality chose an innovative solution that would meet the need, generate an income and simultaneously reduce the requirement for maintenance: By allowing the pumps to run backwards against the pressure of water from its elevated Leliefontein reservoir, electricity for the region's electrical grid could be generated during times when the dam was full.

Generating power

The commissioning of the pump and turbine (PaT) station effectively brings online one of the largest such projects of its kind in South Africa. With all mechanical and electrical efficiencies taken into account, the station is able

to generate 57 kW from its three turbines, which, over the year, produces enough energy to power the entire region's water infrastructure of treatment plants, pump houses, offices and related systems.

"The water comes from the City of Cape Town's Wemmershoek Dam and is gravity-fed to our city regions via our main reservoir. For one month of the year, during the driest month, the pumps are switched on to pump 400 l/s upstream to Paarl to keep the Leliefontein reservoir full. As this is only necessary for that one month, the pumps would usually be switched off for the remaining eleven," explains Henning.

"However, the higher elevation of the reservoir allows us to rotate the pumps backwards to act as small turbines for the rest of the year, which generates electricity at more than an 80% efficiency. Unlike turbines however, the pumps are standard stock items from the supplier, KSB Pumps and Valves, and do not require specialised support and servicing. What's more, they are durable enough to allow us to design the infrastructure with a 40-year lifespan.

"With this long lifespan in mind, we de-



Electrical systems integrator, Brian Cooper at the main control HMI. Pump speeds are controlled via VSDs to prevent overspeed and to convert the electricity produced for compatibility with the city's power grid.

ecided to make use of KSB pumps. We already have a number of these installed throughout our municipality and are aware of their reliability, as well as their long track record of support to our municipality, and other municipalities and water utilities throughout South Africa," Henning adds.

Upgraded pump station

Before commissioning the project, the municipality had spelled out its requirement to replace its existing 96 l/s pump station with a new one and had discussed the ability to generate electricity in the off season with con-

sulting engineers, Aurecon. Having designed and planned a solution, the main contract was awarded to Hidro-Tech systems for mechanical and electrical work.

Kiewiet Viljoen, projects director for Hidro-Tech systems, says the primary role of the project was to develop an efficient and reliable booster pump station to ensure uninterrupted water supply to nearby Paarl. Only once that need had been fully met could the project managers consider its secondary role to generate power in the off-peak season.

"We knew, therefore, that we needed a technologically savvy and reliable service provider so approached KSB Pumps and Valves to procure three KSB ETA200-40 pumps to meet and exceed the requirements of the tender. These not only perform brilliantly as pumps, but in turbine mode have a better than 80% efficiency, even after considering hydraulic and electrical losses. This speaks volumes for the overall efficiency and design of the pumps," says Viljoen.

Technology integration

Electrical systems integrator, Brian Cooper, of Hidro-Tech systems says despite the relative simplicity of the mechanical design, it does require complex integration of controls to deal with the hydraulic force and convert the electricity generated into a useable form. This required pump speeds to be controlled via a variable speed drive (VSD) to prevent overspeed and to convert the wave produced to a pure 50 Hz sine wave for compatibility with the city's power grid.

"The system is designed with full PLC control, which can be managed on site via a Human Machine Interface (HMI) or accessed remotely via computer or a mobile device to give operators infinite control and monitoring of the site wherever and whenever required. The industrial network also provides automated control of the entire system including controls of the three pumps, valves, level indicators, flow meters and other parameters that are critical to the system's efficient operation, in either pump mode or water or electricity generation mode.

"In addition to providing seamless control of the system, the control system ensures redundancy in all operating conditions and provides emergency measures in the event of failures in any part of the system, including valve controls, bypassing of the system or parameter changes as required to rectify any problems incurred," he says.

Solution provider

KSB Pumps and Valves specialist, Stefano Testi, applauded the project, saying its success paves the way for numerous similar projects throughout the Southern African region, wherever there is a reliable supply of water



Kiewiet Viljoen, projects director for Hidro-Tech systems and Drakenstein Municipality engineer for water operations, Hein Henning, at the KSB pump and turbine station (PaT).



KSB Pumps and Valves' branches and dealers manager for South Africa, Francois Naude, with regional sales manager for sub-Saharan Africa, David Jones.

at a high enough elevation to drive the PaT.

"It is particularly useful in areas that would otherwise require the installation of pressure reducing valves to deal with water from high elevations. A PaT can fulfil the requirement while generating electricity for nearby infrastructure or communities, especially rural ones.

"Internationally, KSB is a leader in the supply of PaT solutions and we have a wide range of pumps that are suitable for this purpose. With growing pressure on the country's power generating infrastructure, it pays for local authorities, farmers and landowners with access to water to investigate the installation of PaT systems as cost effective and reliable sources of electricity that are not reliant on wind or sun to drive them," Testi adds.

Project success

Following the commissioning of the pump station and turbines, the system has begun operating at full capacity and the Drakenstein Municipality has started reaping the rewards of its forward-looking water management systems.

"We are pleased with the outcome and commend everybody involved in the project for their innovation and dedication to building a system that can be used as a blueprint by other municipalities around the country and across the globe. It has been a brilliant project with lots of challenges and innovation, with the end result being the delivery of a successful venture. We will definitely do similar projects with this team in future," concludes Henning. □



The Drakenstein Municipality's Leliefontein pump and turbine station (PaT), which pumps water to Paarl for one dry month every year, while generating 57 kW of electricity by running the pumps as turbines, for the remaining 11 months.