Faculty contributes to South Africa's first conduit hydropower facility

South Africa is facing an energy crisis that places additional importance on harvesting all available feasible sources of renewable energy. While the country is not particularly well endowed with conventional hydropower conditions, large quantities of raw and potable water are conveyed daily under either pressurised or gravity conditions over large distances and elevations.

The University of Pretoria, supported by the Water Research Commission (WRC) and other collaborating organisations, such as the City of Tshwane Metropolitan Municipality, Bloemwater and the eThekwini Municipality, has been engaged in a research project to investigate and demonstrate the potential of extracting the available energy from existing and newly installed water supply and distribution systems. The outcome of this project, led by Marco van Dijk of the Department of Civil Engineering, was the development of a counduit hydropower facility at Brandkop in the Free State.

The facility was unveiled on 31 March 2015. The Minister and Deputy Minister of Water and Sanitation, the Premier of the Free State, the Mayor of Bloemfontein, as well as other national, provincial and local dignitaries were invited to witness the unveiling.

The aim of the project was to enable the owners and administrators of bulk water supply and distribution systems to install small-scale hydropower systems to generate hydroelectricity for on-site use and, in some cases, to supply energy to isolated electricity demand clusters or even to the national electricity grid, depending on the location, type and size of the installation. It taps into an unutilised source of hydropower using excess energy in pressurised conduits to produce clean, renewable hydroelectric power. This type of energy generation (conduit hydro-power) is different to conventional hydropower generation where large dams are used to store river water in a reservoir. Its simplicity makes this solution so elegant because it harnesses energy that is already present within the existing water infrastructure. This energy would usually be lost in the presence of a pressure valve.

An initial scoping investigation by the WRC and the University of Pretoria highlighted the potential of hydropower generation at the inlets to storage reservoirs. In South Africa, 284 municipalities and several water supply utilities and mines own and operate water supply and distribution systems that could be considered for small-, micro- and pico-scale hydropower installations.

The application to install hydroelectric turbines in a water distribution system is fairly new in South Africa. Thus, three pilot plants were constructed to showcase several of the intricacies in the development process and to demonstrate the technologies. These sites included the City of Tshwane, the eThekwini Municipality and the Brandkop Reservoir in Bloemfontein. The research project indicated that it is feasible and technically possible to generate energy from water supply and distribution systems.

The WRC and Bloemwater then entered into a partnership to install the first full-scale demonstration unit for conduit hydropower in South Africa. This technology has proven to be a huge success in providing the main supply of energy for operating the Bloemwater Head Office in Pellisier. It can supply 96 kW/h of electricity from a pressurised conduit to power its operational facilities with a full capacity of 360 kW.

The Caledon-Bloemfontein potable water supply system supplies the majority of the water demand in Bloemfontein. The water is supplied to the Brandkop Reservoir, where the Bloemwater Head Office is located. Excess energy is dissipated through pressure control valves before being discharged into the reservoir. Approximately 30% of the water supplied via the Caledon-Bloemfontein pipeline is diverted through the turbine. The benefit of this hydropower-generating application is that minimal civil works are required. There are virtually no negative environmental or social effects that require mitigation and the anticipated lead times are short. Sufficient renewable energy is generated to supply the peak demand of Bloemwater's Head Office, as well as meeting the electricity requirements of the reservoir terrain. Approximately 800 MWh could be generated with this micro-hydropower installation annually.

The Minister of Water and Sanitation, Ms Nomvula Mokonyane, opens the flow to the turbine.

Site before construction.

Constructed turbine room.

Bypass pipework to the turbine.

DB and control panel.

Turbine, generator, control panel and regulators.

Completed turbine room.