The potential of SMALL HYDROPOWER PLANTS in South Africa

Kendal Power station is one of Eskom's coal-fired power stations in Mpumalanga. In recent times, 'cleaner' energies have stepped into the limelight as alternatives to meet rapidly growing demands for power.

Graeme Williams/www.mediaclubsouthafrica.co.za

Renewable energy in the form of hydropower has been cited as one sustainable way for South Africa to meet its future power needs. Petro Kotzé reports.

Renewable energy is the proverbial Cinderella of the energy sector. Overshadowed by coal and other fossil fuels, the possibilities of 'cleaner' energies have stepped into the limelight as alternatives to meet rapidly growing demands for power. Locally, South Africa's ratification of the Kyoto Protocol and government's approval of the White Paper on Renewable energy in November 2003 pushed renewable energy to the forefront. In the latter, a commitment was made to generate 10 000 GWh of power from renewable sources such as biomass, wind, solar, radiation and small-scale hydropower (SSHP) by 2013. Furthermore, South Africa's Integrated Resource Plan for the period 2010 to 2030 calls for the deployment of 17 800 MW of energy from renewable sources.

For some, SSHP specifically holds certain promise even though its contribution to the mentioned White Paper's target is estimated to amount to only 10%. Roughly defined as systems that generate 10 MW and less power, it is often subdivided into pico (generating up to 20 kW), micro (between 20 kW to 100 kW) and mini (100 kw to 1 MW range). It is tagged as a possible solution to some of the major challenges of the African energy solution, like rural electrification and additional capacity for national and local grids. Furthermore, SSHPs produce minimal quantities of carbon and other emissions during construction and operating life, while it is entirely non-consumptive of water. In reality, even though it never reached massive dissemination, South Africa already has a long history with SSHPs.

SMALL HYDROPOWER IN SOUTH AFRICA

Commissioned in 1895, Cape Town Municipality's first power station, and the country's first hydroelectric station was supplied with water from the Woodhead Reservoir on Table Mountain. With two 150 kW generators commissioned on the banks of the Molteno River, the dynamos of the Graaff Electric Lighting Works at Molteno reservoir in Oranjezicht could be driven either by steam or water power. By June 1896, the plant was run by water-power for 2 590 hours and by steam for 691 hours.

Two 6 kW hydroelectric generators were also in use at the Pilgrim's Rest gold mines in 1892, upgraded to 45 kW in 1894. In 1896, a hydro generating station was built at Brown's Hill using two Escher Wyss Girrard impulse turbines coupled to Siemens 160 kW alternators. Jubilee

Power Station was built downstream and an Escher Wyss Francis turbine and a Siemens 150 kVA alternator were installed. These sets were among the first three-phase alternators installed in the country and were used to power the first electric railway (excluding demonstration prototypes on the Witwatersrand in 1892). The railway transported ore to the reduction works over a 12 mile length of track using two 19 kW locomotives.

Bo Barta, author of the 2002 Baseline Study on Hydropower in South Africa (compiled for the Department of Energy) adds that SSHP power generation also played a significant role in the electrification of urban settlements situated along the eastern side of the Drakensberg Mountain range. He says that most of the SSHPs fell into disrepair after the establishment of the Electricity Supply Commission (now Eskom) in 1923 and the national grid. "Eskom could produce sustainable, bulk energy for relatively cheap," says Barta, "and the small schemes, which were relatively seasonal and unsustainable couldn't compete." As a result people started to switch from hydro to coal-based electricity.

Today there are still a number of SSHPs in operation, like the 2 MW Friedenheim Hydro supplying electricity to Nelspruit since 1988 and the 0,8 MW Bakenkop Hydro at Piet Retief (still in working order after more than 50 years). In total (excluding mines) there is an estimate 42 MW of power supplied by SSHPs in the country. Notable is Bethlehem Hydro, the first hydropower plant to be commissioned in South Africa since 1988. The 7 MW operation entails two plants, a 3 MW operation on the wall of the Sol Plaatje Dam, and a 4 MW run-of-river plant at Merino. It is managed by Independent Power Producer (IPP) NuPlanet and sells its electrical power and capacity under a long-term power purchase agreement (PPA).

According to the mentioned baseline study, there is still significant potential for SSHP development in South Africa, particularly in the Eastern Cape and KwaZulu-Natal. Barta maintains that South Africa's lack of water resources should not necessarily be seen as detrimental for this purpose. This is because hydropower can be derived not only from conventional sources, like rivers but also through more unconventional means; including tapping hydropower from existing infrastructures.

SMALL HYDRO POTENTIAL

Conventional small hydropower installations (run-of-river) often involve the construction of a weir and a simple intake structure with water transferred by a conduit or canal to a suitable point. Here it is dropped through a penstock to the turbine or generator. Also referred to as 'greenfield' hydropower sites, it typically needs to be situated on rivers with relatively constant flow and a suitable water drop, and is mostly suitable for mini and pico hydropower sites.

Barta estimates that there is also potential to blow life back into some of the existing SSHP installations scattered around the country, most notably at Belvedere (2 MW), Ceres (0,8 MW), Clanwilliam (1 MW), Kouga (5,3 MW), Ncora (2,4 MW) and Pongolapoort (2,7 MW) and "a few other smaller privately-owned installations".

More unconventional, mostly untapped potential includes South Africa's inter-basin transfer schemes, where SSHPs can be installed at locations where a gravity water supply scheme component is present. Suitable sites identified in Barta's updated 2010 feasibility report include the Breede/Berg, Lesotho Highlands Water Project, the Orange/Modder, Vaal/Crocodile, Thukela/Vaal and, 'most promising', the Orange/Fish Water Transfer Scheme. However, many systems including irrigation canals, environmental water releases (from large and medium dams) and bulk water supply pipelines can also be utilised, as the potential to generate power in these systems are currently going to waste.

Rand Water, for example, intends to install four SSHPs within their hydraulic network. According to Rand Water Senior Mechanical Engineer Iveen Mbhele, the water supply to turbines will be tapped from the existing water supply pipelines and fed back to the pipelines. These are currently at tender stage for the supply and installation of four hydropower plants, of which commissioning is expected to take place in 2014/2015. The combined capacity of the four plants will not be more than 16 MW and will be fed into the national power grid, although the main aim is to offset Rand Water's high energy bill, Mbhele says. He adds that the four sites are at Zoekfontein (about 8 km from Vaal

NuPlanet

Bethlehem Hydro's 3 MW operation on the wall of the Sol Plaatje Dam.

Dam), Klipfontein (Kempton Park area), Brakfontein (Midrand area) and Hartebeeshoek (Roslyn area), but there are more sites that will be explored in future.

For power giant Eskom, which has a total net capacity of almost 41 000 MW, but still needs to provide for South Africa's demand for power – expected to double by 2030 from present levels of around 37 000 MW, SSHPs might not be the answer. The potential can, however, be untapped by IPPs. According to Doug Kuni, Independent Power Producers' MD, IPPs are designed to be quick and nimble, and can be viable solution for power supply in a power-short country. Government has initiated a number of programmes aimed to support IPPS.

REGULATORY ENVIRONMENT

Following Cabinet's approval of the White Paper on Renewable Energy, the Department of Energy (DoE) proceeded with the development of its renewable energy strategy. The implementation plan of the various technologies was identified in a macroeconomic study undertaken in 2003. This study highlighted the technologies to be implemented first, based on the level of commercialisation of the technology and natural resource availability. Mini-hydroelectric schemes were included with these, along with sugarcane bagasse (the fibre that comes from crushing the sugar cane) for cogeneration, landfill gas extraction and commercial and domestic solar water heaters. The DoE also established the Renewable Energy Finance and Subsidy Office (REFSO), whose mandate includes the management of renewable energy subsidies, offering advice to developers and other stakeholders.

Regardless of government initiatives, few small hydropower developments are taking place. Kuni says that the challenges that IPPs face are "extreme" and largely structural and regulatory as they are highly dependent on government programmes. Obtaining the right permission and licensing agreements is a long and intricate process, often involving the Departments of Public Enterprise, Energy, Water Affairs, Eskom and the National Energy Regulator of South Africa (NERSA) and more. Furthermore, IPPs are largely dependent on Eskom, which controls who can access the grid. Anton-Louis Olivier, NuPlanet MD agrees that rules and regulations that IPPs have to adhere to are big factors. He adds that start-up funds are also often substantial, and there is thus huge risk involved.

Nevertheless, he is positive that the country's Integrated Resource Plan for 2010 to 2030 could be a massive injection for the renewable sector. The plan envisages renewables contributing 42%, or 17 800 MW of the country's new generation capacity by 2030. The DoE also allocated capacity across various renewable technologies, with 1 850 MW set aside for onshore wind, 200 MW for concentrating solar thermal, 1 450 MW for solar photovoltaic solutions, 12,5 MW for both biomass and biogas, 25 MW for landfill gas capacity, 75 MW for small hydro, and a further 100 MW for other small-scale IPP projects of less than 5 MW. Speaking on small hydro specifically, Olivier says that the generation of 75 MW would create hundreds of job opportunities, and be a huge financial injection into the sector.

The DoE has put out a tender for the procurement of the first 3 725 MW of renewable capacity by 2016, which is likely to attract local and international investment of between US$10 billion and US$12 billion. Potential bidders for the supply of the first 3 725 MW of renewable power, including onshore, concentrated solar, biomass and small hydro, had until 4 November to submit their bids for consideration. The preferred bidders were to be announced at the UN Climate Summit in Durban in November. Another positive development is a collaborative effort between the Department of Water Affairs (DWA), National Treasury, Eskom and the NWRI under coordination with the DoE. It entails the implementation of a pilot project for small hydropower generation at the Vaal Dam as well as the compilation of a list of 20 other possible sites earmarked for feasibility studies for small-scale hydropower plants. These sites are located within government infrastructure, but IPPs could be allowed access for hydropower development should the process be completed successfully.

Henriëtte Anderson, DWA Chief Director of Engineering Services, says that an initial screening process has commenced and will be completed in the near future. During the process, a hydropower engineer investigates all the sites for possible fatal flaws that IPPs may encounter should the sites be developed. These could include issues such as sustainability, affordability and technical, operational and financial risks. It is foreseen that the initiative will help create an enabling environment for IPPs to generate hydropower after a competitive tendering process has been followed. Anderson adds that it seems "very likely" that they will proceed with some of the sites. The way forward after the screening of these sites has been concluded will be determined by the National Treasury. ❑

People started to switch from hydro- to coal-based electricity after the establishment of Eskom. Today, remnants of the Graaff Electric Lighting Works are reminders of South Africa's history with small hydro power plants.

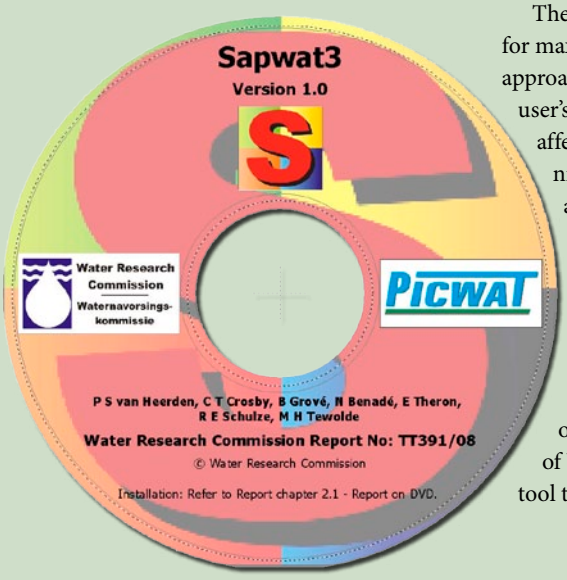
Bruce Sutherland, City of Cape Town

World Agri Award – SA does it again

South Africa has confirmed its status as a world leader in the drive towards irrigation water use efficiency following another international award.

This is after the International Committee on Irrigation and Drainage (ICID) awarded the country its fourth WatSave Award in the last five years during the 21st International Congress on Irrigation and Drainage held in Iran earlier this year. The accolade in the 'Innovative Management' category was awarded to the SAPWAT3 irrigation planning and management tool project managers Pieter van Heerden and Charles Crosby.

The original SAPWAT program was released in 1999. Since then the irrigation requirement and scheduling tool has gained general acceptance in South Africa. SAPWAT is not a crop growth model, but rather a planning and management tool relying heavily on an extensive South African climate and crop database. It is general in applicability in that the same procedure is used for vegetables and field crops, annual and perennial crops, as well as pasture and tree crops. With this program it is possible to simulate wide-bed planting, inter-cropping and different irrigation methods. In addition, the effect of soil water management options, such as deficit irrigation, can be evaluated.



Irrigation strategies can be varied to demonstrate the effect of different strategies on irrigation requirement. This allows the user to devise irrigation strategies aimed at maximising rainfall use efficiency and thus reducing irrigation water requirement. In addition, salinity stress and water stress situations can be imitated. All irrigation requirement estimates can be stored and revisited to determine what effect changes in irrigation water management, irrigation system and changes in planting dates could possibly have.

Since its introduction, SAPWAT has been applied by more than 300 users in 13 countries, including Angola, Mali, Mozambique, Swaziland, Niger, Namibia and Uzbekistan. Through the years the program has been continuously upgraded and improved, mainly with funding from the Water Research Commission. The latest version, SAPWAT3, was released in 2008. Today, SAPWAT3 is used by all irrigation designers in South Africa to optimise water use to its fullest extent.

The latest version is designed for maximum user interaction, an approach which contributes to the user's understanding of issues affecting good irrigation planning and management. This approach has the added benefit that SAPWAT3 serves as a good training and demonstration aid. Water savings have been achieved in a number of water management areas and, as a result, officials of the Department of Water Affairs are using the tool to quantify the optimum amount of water for a specific command area. The department has also endorsed SAPWAT3 as a tool to issue water use licenses for irrigation purposes.

Apart from the WatSave Award, the South African delegation walked away with several additional accolades from the ICID congress. WRC Director: Water Utilisation in Agriculture Dr Gerhard Backeberg was appointed Vice President while WRC Research Manager in the same department, Dr Andrew Sanewe, was appointed chair of the African Working Group. In addition, South Africa won the award for 'Best National Committee' for a third year in a row. This is a considerable achievement considering that ICID is represented by 110 member countries. ❑

Below: *Newly-elected Chair of the African Working Group, Dr Andrew Sanewe, new ICID Vice President Dr Gerhard Backeberg and Chair of the South African National Committee on Irrigation and Drainage (SANCID), Felix Reinders, at the ICID Congress in Iran.*

Bottom: *: SANCID Chair, Felix Reinders, receiving the WatSave Award from ICID President, Prof Chandra Madramootoo, on behalf of SAPWAT project leaders Pieter van Heerden and Charles Crosby.*