Gearing up to meet Africa’s rising power and water demand

Bloemwater head-office is becoming energy independent with its own conduit hydropower generation plant

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What is conduit hydropower?
- Background
- Benefits of conduit hydropower
- Bloemwater hydropower
- Bloemwater - Hydropower Plant Brandkop
- Launched - Success
- Conclusion
What is conduit hydropower?

“Conduit hydropower” – energy generated from pressurised conduits
Background

- Drivers for a water utility to consider “hydropower”:
  - Renewable energy source
  - Rising energy costs
  - Reduced revenues
  - Financial incentives
  - Public perception
  - Job creation
  - Extending the operational life of control valves
  - Remote power (alarms, communications etc.)
Background - Our involvement

**Title:** Energy generation from distribution systems

**Period:** 2 (3) years

**Funding:** Water Research Commission with a number of collaborating organisations
Background - Our involvement

Reports:
TT597/14 - Conduit hydropower development guide
TT596/14 - Conduit hydropower pilot plants
Benefits of developing conduit hydropower

- Hydroelectric energy is a continuously renewable energy source.
- Hydroelectric energy technology is proven technology offering reliable and flexible operations.
- Hydroelectric stations have a long life
- Hydropower stations achieve high efficiencies.
- Conduit hydropower uses the *available water distribution infrastructure* and thus as long as there is a demand for water hydroelectric energy can be generated.
- The operational life of the existing pressure reducing valves is extended.
- Conduit hydropower “piggy backs” onto existing water infrastructure resulting in a minimal environmental impact.
- The preliminary feasibility studies indicate short payback periods.
Bloemwater hydropower

[Diagram of Bloemwater hydropower system with labels such as Bloemfontein, Hamilton Park, Brandkop, De Brug, Bloemspuit, Lieuwkop, Lesaka pipeline, Rustfontein Dam, Groothoek Dam, Mockes Dam, Masselspoort, and Reddersburg.]

Legend:
- Water purification works
- Reservoirs
- Towns
- Pump stations
- Dams
- Pipeline

www.african-utility-week.com | www.clean-power-africa.com
Bloemwater hydropower
Bloemwater hydropower (Brandkop Reservoir)
Site location Brandkop Reservoir
Bloemwater - Hydropower Plant Brandkop

Electricity consumption

30 Minute Demand - BLOEMWATER

Time From 10:00 on 2012/11/14 to 09:30 on 2013/01/14 (->)

www.african-utility-week.com | www.clean-power-africa.com
Bloemwater - Hydropower Plant Brandkop

30 Minute kW Demand vs % Time

Electricity consumption

Data Used: From 10:00 on 2012/11/14 to 01:00 on 2013/01/16
Bloemwater - Hydropower Plant Brandkop

- IREM Crossflow turbine and generator
- Nominal voltage: three/single phase 400/230V 50Hz
- Generated electric power: \( P = \pm 96 \text{kW} \)
- Net head axis turbine: \( H = \pm 40 \text{ m} \)
- Flow: \( Q = \pm 350 \text{ l/s} \)

- **ECOWATT Micro hydroelectric power plant type TBS**
  - Cross Flow turbine in stainless steel type 4-0.5
  - Synchronous generator type AZ 100
  - Revolution multiplier by cogged driving belt
  - Automatic flow regulation (with electric actuator 230Vac)
Bloemwater - Hydropower Plant Brandkop

- **Electric Distribution Board Mod. CT 100.000**
  - a voltmeter, a digital frequency-meter, ammeters indicating the total current distributed by the generator, ammeters indicating the current drawn by the consumers
  - magneto thermal, which protects the generator from possible short circuits on the consumer line
  - electronic voltage relay, operating a warning buzzer and a visual signal in the event the voltage variation exceeds the limits

- **Electronic Regulating System RMP 12000/B with water dissipation resistances**
  - box unit, which include the electronic control board to micro processor and the power control
  - transient voltage protection (TVP)
  - resistors for dissipation equipped with 9 x 12 kW
Bloemwater - Hydropower Plant Brandkop
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Launch - Success

- Launched plant - 31 March 2015

- Supplies the entire Bloemwater head office
Launch - Success

- Bloemwater Board gave its full support for this new endeavour (bold step). Due to the success they are already starting to investigate and invest in other opportunities.
- Also assisted in knowledge dissemination and showcasing of the application of this technology.
- To operate the system effectively requires a better understanding of the whole system.
- Energy water nexus - Integration of WTW, pipeline capabilities and characteristics, demand pattern and the electricity requirements from head office.
Launch - Success

- Bloemwater achieved exploiting this productive synergy between the water and energy systems.
- Please view the YouTube video of this project: The Power of Hydro: Bloemwater Conduit Hydropower Plant Project video https://www.youtube.com/watch?v=um4alk53hrs
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure and flow measurements</td>
<td>The available head versus flow relationship is required to select a suitable turbine.</td>
<td>R25 000</td>
</tr>
<tr>
<td>Electricity consumption data</td>
<td>A monitoring system was installed measuring the electricity consumption of Bloemwater head office. Peak electricity consumption and daily pattern is required.</td>
<td>R20 000</td>
</tr>
<tr>
<td>Dynamic analysis</td>
<td>A dynamic analysis is required to ensure the safe operation of the hydropower plant.</td>
<td>R40 000</td>
</tr>
<tr>
<td>Valve chamber</td>
<td>Modifications to existing valve chamber providing off take and valve chamber.</td>
<td>R40 000</td>
</tr>
<tr>
<td>Pipe and valve work</td>
<td>Supply and installation of off-take pipeline (500 mm diameter) including bends, isolating valve, reducers and pressure control/regulating valve (400 mm control valve).</td>
<td>R445 000</td>
</tr>
<tr>
<td>Cross-flow turbine</td>
<td>Manufacture and supply of cross-flow turbine with bottom outlet, synchronous 3-phase generator, electronic regulator and control panel.</td>
<td>R1 350 000</td>
</tr>
<tr>
<td>Electrical connection to BW offices</td>
<td>Providing and installing electrical cable connecting to BW head office (distance ±200 m). Modifications to electrical panels, switching between municipal and hydroelectric power.</td>
<td>R650 000#</td>
</tr>
<tr>
<td>Turbine room</td>
<td>The turbine, generator, electric control panel, monitoring equipment and regulator is housed in a brick walled lockable structure with safety signs, lighting, cameras etc.</td>
<td>R535 000</td>
</tr>
<tr>
<td>Monitoring system</td>
<td>Installing monitoring system of power output from generator, net power to the external load, system voltage, gross and net system current, status of all shutdown functions etc.</td>
<td>R30 000</td>
</tr>
<tr>
<td>Data logging and communication system</td>
<td>Logger with internal modem to capture data remotely installed in the Turbine room. Additional pressure transducers and monitoring equipment was also installed.</td>
<td>R60 000</td>
</tr>
<tr>
<td>Flow measurement</td>
<td>An ultrasonic flow meter was installed on the off-take to the turbine connected to the data logger.</td>
<td>R40 000</td>
</tr>
<tr>
<td>Design and implementation</td>
<td>Assistance with design, turbine selection and implementation</td>
<td>R225 000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>R3 460 000</strong></td>
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</table>
Conclusion

• Conduit hydropower is the “low hanging fruit” which can be developed

• Based on current spending of Bloemwater head office on monthly electricity bills will result in a payback period of 60-72 months for this project i.e. approximately 5-6 years.

• The theoretical generation from this hydropower plant is 830 000 kWh/a (based on annual average flow and pressure values).
THANK YOU!

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