Renewable energy and energy efficiency for wastewater treatment works in South Africa

Technical factsheet for **pumps and motors**

01 Energy management and optimisation

02 Pumps and motors

03 Primary and tertiary treatment

04 Sludge management

05 Secondary treatment

06 Solar photovoltaic (PV) technology

07 Biogas combined heat and power

08 Mini-hydro and wind power

09 Thermal beneficiation and treatment of wastewater sludge

10 Energy storage systems

This factsheet on pumps and motors forms part of a series of ten (10) factsheets that highlight the renewable energy (RE) and energy efficiency (EE) technologies relevant to wastewater treatment works (WWTWs). The full list of technologies and factsheets can be found [here].

Wastewater treatment works (WWTWs) are large consumers of energy, with water supply and wastewater treatment constituting approximately 17% of the total energy consumed by South African municipalities.

Innovative approaches to efficient energy use in municipal WWTWs, specifically through increased EE and greater adoption of RE technologies such as biogas, solar, wind power, thermal power and hydropower, can reduce spend on energy bills and enable sustainable delivery of water services. The adoption of EE and RE technologies supports climate change mitigation as it decreases the amount of electricity consumed and the associated greenhouse gas (GHG) emissions, while improving resilience to disruptions such as planned power outages (loadshedding).

This factsheet is written for:

- Municipal officials interested in:
  - > Unpacking feasible options for energy savings, and reducing the overall WWTW facility energy bill.
  - > Reducing the carbon footprint of the WWTW.
- Businesses and engineering, procurement and construction (EPC) companies that are looking for opportunities to explore in the WWTW market.
- Investors interested in identifying feasible RE and EE projects at WWTWs.

This factsheet discusses:

- The interventions that can be undertaken at wastewater treatment works to reduce the electricity consumption of pumps and motors.
- The business case and market assessment to implement interventions that will reduce electricity consumption of pumps.

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01 Introduction

Pumping can account for 4% – 30% of the energy used to operate a municipal treatment facility (water and wastewater). There are various improvements in motors and pump efficiency that can reduce the energy consumption and subsequent costs in the plant.

1.1 Where at a WWTW can EE interventions for pumping be evaluated

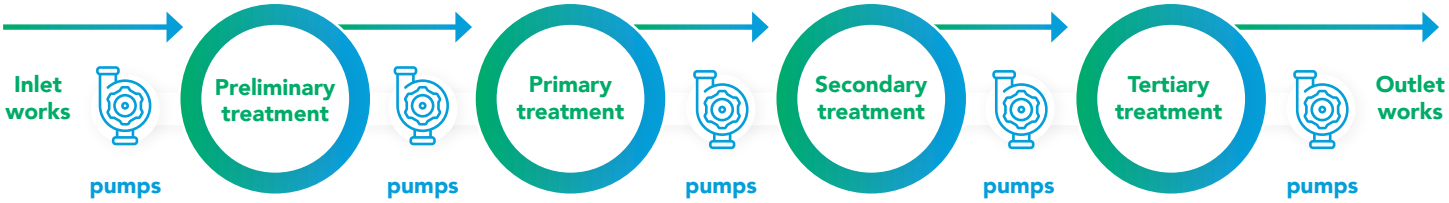

Figure 1: Input-Output diagram demonstrating pump usage in wastewater treatment works

The overall efficiency achieved in a pumping system depends on the types of pumps, drives, and motors used. As shown in Figure 1, pumps are required at the inlet works, within the plant and at the outlet works. The energy intensity of the pumps at each stage differs by plant size and geographical elevation.

1.1.1 Pump optimisation

There are various interventions that can be deployed to enhance EE in pump systems. Some interventions, such as adjusting the calibration of valves and reducing pump usage during low-flow periods do not require any capital, while others are more capital intensive but result in higher energy savings. Figure 2 demonstrates the types of interventions[1] by their estimated payback period and energy savings potential.

1 For further descriptions and other interventions see: A practical guideline for Energy Efficiency Audits at Wastewater Treatment Works prepared by Water Group Holdings (Pty) Ltd in partnership with SALGA, DMRE and GIZ

PAYBACK PERIOD	
< 1 YEAR	**1–3 YEARS**
Determine pump system efficiency over the range of pumping requirements and stage pumps for optimum energy use	Smart systems and monitoring: Install real-time energy monitoring system to verify demand consumption and adjust parameters
Adjust basin fluid levels to decrease pump head and reduce pump load. Wet-well levels can be raised in pumping stations to reduce pump head	Replace old pumps with high efficiency pumps
If required, adjust the pump speed by using a variable frequency drive (VFD) or adjust the system curve by throttling the system curve	Installing variable speed drives to enable load matching
Identify and adjust poorly calibrated valves	Improving piping and valves to decrease losses due to friction
	Impeller trimming on oversized pumps
Reduce number of pumps in use during periods of low-flow	
Optimise Return Activated Sludge (RAS) flow rate	
Up to 10%	**10 – 50%**
Estimated Energy Savings	

Figure 2: Interventions to reduce energy consumption of pumps

1.1.2 Motor optimisation

Similar to pump optimisation, there are various interventions that can be deployed to enhance the energy efficiency in motors. Some interventions, such as cleaning and adequate lubrication checks, do not require any capital, while others are more capital intensive but result in higher energy savings. Figure 3 demonstrates the types of interventions by their estimated payback period and energy savings potential.

PAYBACK PERIOD	
< 1 YEAR	**1 – 3 YEARS**
Ensure motor controls – timers, thermostats and sensors – are working	Optimise Return Activated Sludge (RAS) flow rate
Develop a schedule to switch-off pump motors when not required	
Check for oil leaks and adequate lubrication of bearings	
Ensure motor controls – timers, thermostats and sensors are working	
Ensure motor is well ventilated – fan end is opened	
Check that motors are clean and free of debris and dirt	
Up to 10%	**10 – 30%**
Estimated Energy Savings	

Figure 3: Interventions to reduce energy consumption of motors

A guide on energy savings in motor systems can be found on the South African-German Energy Programme website (www.sagen.org.za)

1.2 Business case

The implementation of different pump and motor EE interventions presented in **Figures 2 and 3**, can yield potential energy savings of > 50% with ranging payback periods.

Follow these steps to build a business case for an intervention:

1. Calculate the current energy consumption of pumps and motors at your treatment work.
2. Select the intervention relevant to your treatment work.
3. Investigate the costs associated with the intervention.
4. Investigate the technical skills required for the uptake and maintenance of the technology (if relevant).
5. Calculate the payback period of the intervention based on the estimated energy savings.

The general interventions in Table 1, outline the potential energy savings that can be expected.

Table 1: Potential energy savings per intervention

INTERVENTION	POTENTIAL ENERGY SAVINGS (%)	PAYBACK PERIOD (YEARS)
Pump system optimisation (with little/no equipment)	0 – 10	<2
Pump system optimisation (with retrofitting)	10 – 50	<3
Motor optimisation (with little/no equipment)	0 – 10	<1
Motor optimisation (with retrofitting)	10 – 30	<3

1.3 Financing mechanisms

Potential EE projects can be financed through various financing mechanisms depending on the nature of the project, municipality's implementation capacity, financial strength, borrowing capacity, revenue base and commercial financing environment.

Table 2: Financing mechanisms for energy efficiency projects

MECHANISM	DESCRIPTION	EXAMPLES
Municipal budget	EE projects funded from municipal revenues.	EE projects motivated and included in IDP, WSDP, SDBIP and Project business plans.
Grants	Non-repayable funds from government or donors to municipalities.	Conditional grants (MIG, RBIG, WSIG), Green Fund and EEDSM
Concessional loans (Dedicated credit lines)	Soft public loans to municipalities for EE projects from foreign funders. They usually have lower interest rates.	AFD, SEFA (AFDB), DBSA
Commercial bank loans	Commercial banks lend money to municipalities for EE projects or through Energy services companies (ESCos).	Most commercial banks fund sustainable projects.
Energy performance contracts (Vendor credits)	Financing of EE equipment/ services covered by the ESCos with repayments based on estimated future energy savings. Alternatively, the initial costs are paid by the municipality and the ESCo is required to guarantee energy savings and pay the difference if the expected savings are not achieved.	City of Cape Town SANEDI ESCo register
Climate financiers	Finance for activities aiming to mitigate or adapt to the impacts of climate change.	See: https://greencape.co.za/archives/green-finance-databases/

Source: ESMAP: Financing Municipal Energy Efficiency Projects; NBI: Private Sector Energy Efficiency Programme; and SALGA: Financing Energy Efficiency and Renewable Energy

AFD = French Development Bank, DBSA = The Development Bank of Southern Africa, ESCo = energy service companies, MIG = municipal infrastructure grant, RBIG = Regional bulk infrastructure grant; SEFA = Sustainable Energy Fund for Africa;

WSIG = water services infrastructure grant

Next steps

- Conduct a comprehensive preliminary level 1 energy audit of WWTWs. [A detailed guideline for EE audits at WWTWs can be found (here)].
- Identify areas of high energy demand and feasible interventions to promote EE.
- Conduct a financial pre-feasibility study and identify a feasible financing model/s.
- Explore other EE and RE interventions [biogas, hydro power, pre and post treatment, pumping, sludge management, solar PV, and thermal beneficiation].

Pipeline development to deploy **clean energy technology solutions in municipal wastewater treatment works of South Africa**

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- Department of Cooperative Governance and Traditional Affairs
- Department of Science and Innovation
- Development Bank of Southern Africa
- National Treasury
- South African Local Government Association
- Municipal Infrastructure Support Agent
- South African National Energy Development Institute

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