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

Technical factsheet for **energy storage systems**

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

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09 Thermal beneficiation and treatment of wastewater sludge

10 Energy storage systems

This factsheet on energy storage systems forms part of a series of ten (10) factsheets that highlight the renewable energy and energy efficiency technologies relevant to wastewater treatment works (WWTWs). The full lists 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 energy efficiency (EE) and greater adoption of renewable energy (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 (load shedding).

This factsheet is written for:

- Municipal officials that want to understand energy security options or increase renewable energy penetration.
- Investors interested in identifying feasible renewable energy and energy efficiency projects at wastewater treatment WWTWs.
- Water and energy sector businesses that are looking to identify potential market opportunities.

This factsheet discusses:

- The types of energy storage systems applicable to WWTWs.
- Why energy storage is necessary.
- How energy storage is used.

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Introduction

Energy storage systems are technologies in which electric energy is saved and, when needed, discharged for consumption. Several technologies are making in-roads in the South African backup energy storage sector. Lithium Ion (Li-ion) and lead-acid battery technologies are the most tried and tested. They remain the leaders in this market, with the li-ion being a dominant choice due to its short-duration performance, faster charging times, and proven operational stability. There has been a 90% decrease in the cost of li-ion batteries since 2010, and there are further indications of lower price potential due to developments in technology and manufacturing. Li-ion energy storage will be the focus of this fact sheet due to its market dominance.

1.1 How does Li-ion energy storage work?

Li-ion batteries store electrical energy in the form of chemical energy for later use. The electrical energy source can be from the national grid or alternative energy sources like solar PV. The primary components that make up a typical storage solution:

- **AC/DC Inverter:** Grid power is Alternating Current (AC), and li-ion uses Direct Current (DC).
- **Battery management system** (BMS) determines when a battery should be charged or discharged.
- **Li-ion battery:** Lithium-ion cells combined to electrochemically store electricity.

Energy storage systems are typically placed behind the meter. A simplified diagram of an energy storage application for WWTW is shown in **Figure 1**.

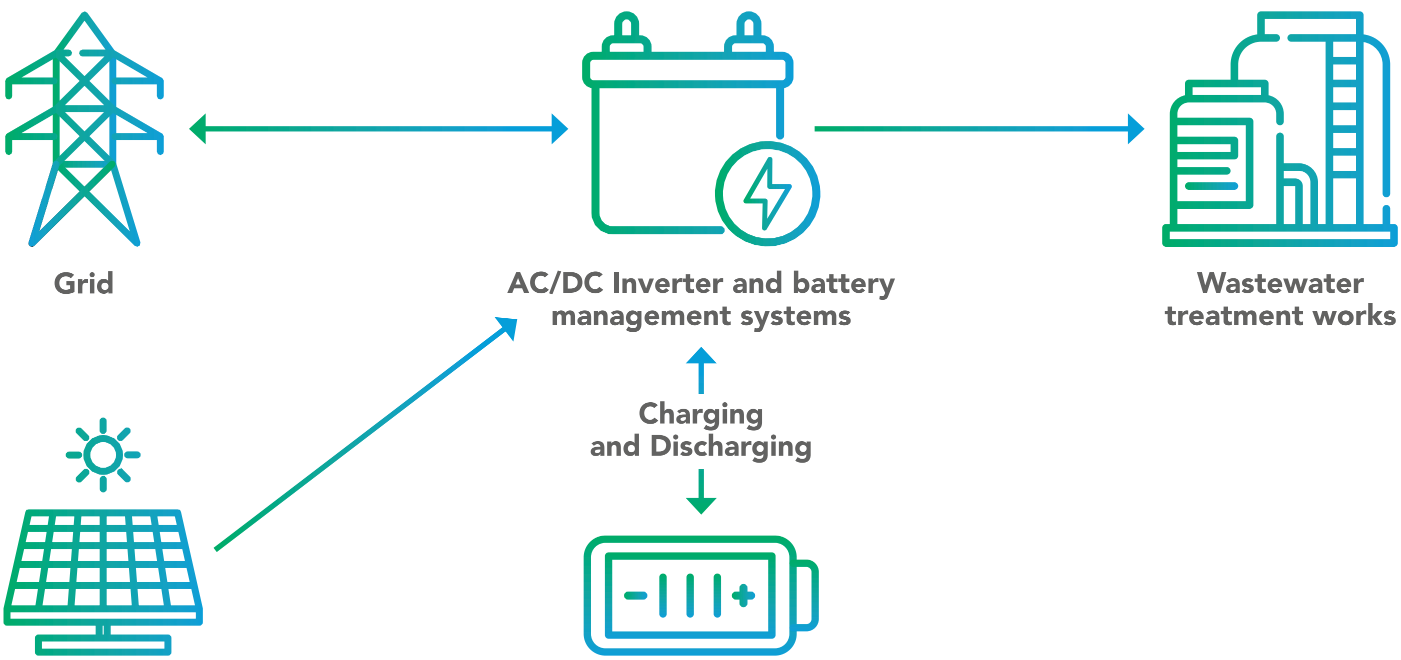

Figure 1: Energy storage configuration

1.2 Can energy storage reduce the energy consumption of the WWTW?

Energy storage does not reduce energy consumption. Energy storage aims to ensure backup power to the WWTW or to increase the penetration of other renewable energy technologies.

CONSIDER THIS TECHNOLOGY IF		
Energy efficiency interventions have already been implemented. • To minimise costs and correctly size energy storage systems, energy efficiency measures should ideally first be implemented.	**Backup power is needed to ensure the facility is operational when there is no power from the grid. Two scenarios can be considered:** • Energy storage is a backup device used for grid resilience. **Scenario 1: Energy storage stand-alone.** • The current backup power device is Diesel generation, and the operational cost has become too high. **Scenario 2: Energy storage to displace diesel.**	**There is a need to reduce carbon emissions further; a third scenario can be considered.** • By oversizing renewable energy and storing the excess renewable energy generation for later use can support increased use of clean energy. **Scenario 3: Energy storage to increase renewable energy penetration.**

Business case

Table 1: Financial metrics for different energy storage scenarios

Case	SCENARIO 1	SCENARIO 2	SCENARIO 3
	Energy storage (stand-alone)	**Energy storage vs diesel generation**	**Energy storage with solar PV**
Payback period	–	12 – 20 years	6 – 12 years
IRR	–	0 – 3 %[1]	8 – 10 %
Fixed O&M costs	2% of Capital cost	2% of Capital cost	2% of capital cost
Carbon emissions reduction	–	605 – 1058 kgCo$_2$ per kW per annum for offsetting diesel generation.	118 – 207 kgCo$_2$[2] per kW per annum for offsetting grid power.

The capital cost of li-Ion storage ranges between R4000 – R8000 R/kWh, kWh represents the duration of storage depending on the installation size. The balance of system cost is between R4500 – R6000 R/kW. kW represents the size of the load.

1 Financial metrics are very dependent on the price of diesel.

2 The carbon emissions from South Africa's national utilities carbon-intensive generation are more favourable than diesel generators on a kWh basis; economies of scale have an impact.

Financing mechanisms

Potential EE projects can be financed through various mechanisms, depending on the nature of the project, municipality's implementation capacity, financial strength, borrowing capacity, revenue base and commercial financing environment. Some examples are shown in Table 2.

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 technical pre-feasibility and feasibility study to outline sizing requirements for plant size.
- Conduct a financial pre-feasibility study and identify a feasible financial model.
- Ensure that all other energy efficiency interventions have been concluded or at least quantified (this could influence the future energy requirements which can influence the size of the installations).
- Conduct and map out technical design and specification requirements.
- Explore feasible procurement options.
- Conduct Risk Management assessment of each phase.

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

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> Department of Science and Innovation
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> National Treasury
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