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

## Technical factsheet for **thermal beneficiation and treatment of wastewater sludge**

01 Energy management and optimisation

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03 Primary and tertiary treatment

04 Sludge management

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06 Solar photovoltaic (pv) technology

07 Biogas combined heat and power

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10 Energy storage systems

This factsheet on energy management and optimisation forms part of a series of ten (10) factsheets which 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:
  - > Reducing the amount of solid wastes being produced at wastewater treatment works.
  - > Offsetting energy use by generating additional electricity and/or heat to integrate into the WWTW process.
  - > Increasing efficiency, throughput, and biogas output of planned/existing anaerobic digesters.
- Private companies and investors in the waste management sector looking for potential opportunities in the beneficiation of WWTW sludge.

### This factsheet discusses:

The practical and financial implications of thermal hydrolysis when integrated with the WWTW process.

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# Introduction

The thermal beneficiation of organic wastes refers to thermal processes that result in the generation of energy and co-products when organic waste is subjected to heat. A method of thermal beneficiation that is gaining traction in the wastewater industry is thermal hydrolysis. Thermal hydrolysis is a method of processing organic waste for anaerobic digestion using heat and pressure that increases the amount of and rate at which biogas is produced in consequent anaerobic digestion. This excess biogas can be used either directly to supplement heating requirements of the facility or can be converted to electricity. The resulting solid residues from anaerobic digestion and thermal hydrolysis are more easily dewatered and are stable, pasteurised, and free of pathogens.

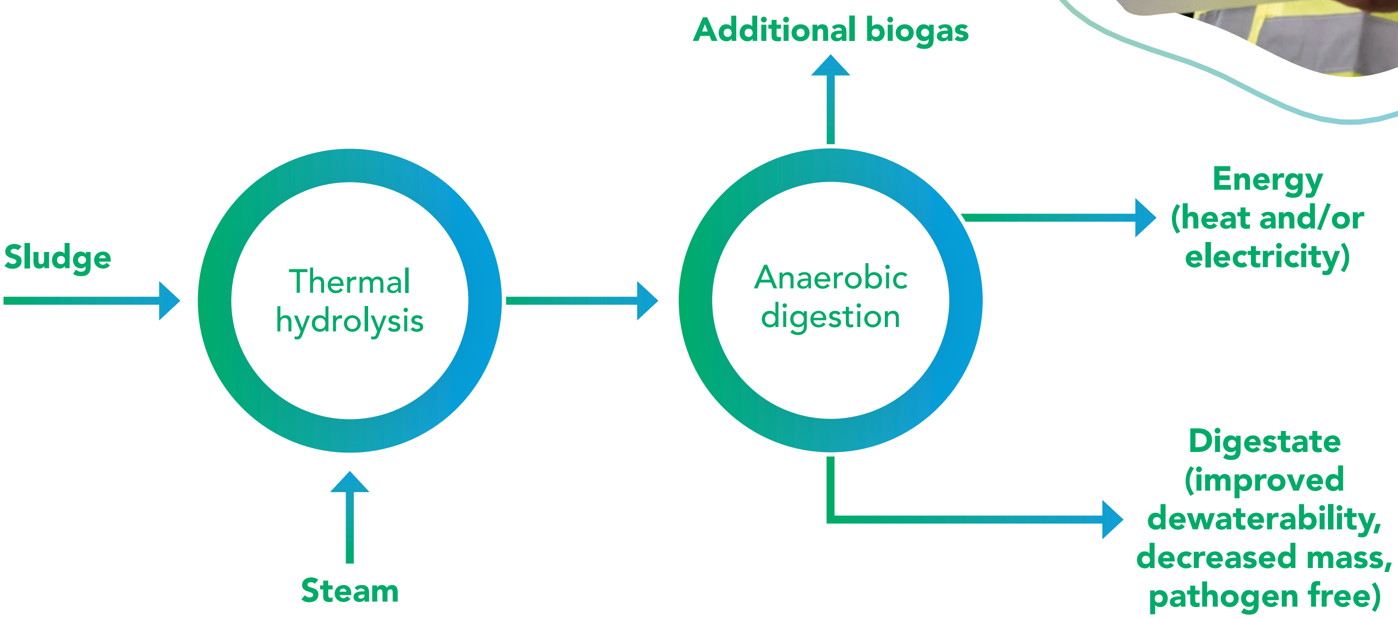



**Figure 1:** Process diagram for thermal hydrolysis of sludge

## 1.1 Thermal beneficiation of WWTW sludge

The solid residues produced by WWTWs pose a problem as significant costs can be incurred disposing of them. It is estimated that upwards of R300 million is spent annually on WWTW sludge disposal costs in South Africa[1]. Sludge poses health and environmental risks when improperly managed. Landfilling or stockpiling large volumes of WWTW sludge puts strain on landfill capacity and increases the footprint of WWTW operations.

Thermal hydrolysis is a process technology that breaks down sludge by treating it with steam using a combination of high pressure and temperature as well as rapid pressure drop, which occurs when the pressure is released.

Applying thermal hydrolysis as a pre-treatment for anaerobic digestion has benefits such as:

- Sludge is more readily converted into biogas and does not contain any pathogens
- Increased digester efficiency and throughput by reducing retention time in the digester without decreased biogas output
- The solid residues from anaerobic digestion when operating in conjunction with thermal hydrolysis have a reduced mass and increased dewaterability, saving on the energy demands of the drying process.

**Table 1:** Process characteristics of thermal hydrolysis of WWTW sludge

| | |
|---|---|
| **PRODUCTS** | Pre-treated biomass for anaerobic digestion, additional biogas |
| **APPLICABILITY** | Upstream, downstream, or in parallel with anaerobic digesters (depending on most suitable process configuration) |
| **MATURITY** | Widespread in industry internationally, planned projects in SA |
| **TYPICAL ENERGY YIELD** | 15-60% biogas production increase[2] |
| **SLUDGE MASS REDUCTION (DRY BASIS)** | 7-8% improved dewatering[3] |
| **TYPICAL SCALE** | >1 500t/year dry feedstock[4] |

## 1.2 Energy integration of thermal beneficiation with WWTW

The additional energy generated by the addition of thermal hydrolysis can be used to aid up and downstream wastewater treatment activities. Apart from the heat required to facilitate thermal hydrolysis, additional heat can be utilised in the sludge drying process, drive steam generation, or to heat anaerobic digesters to further improve digester performance. The biogas produced by these processes can also be used for electricity generation using combined heat power. (refer to the fact sheet on biogas combined heat and power)

2 Performance of CAMBI thermal hydrolysis plant https://www.wef.org/globalassets/assets-wef/2-resources/online-education/eshowcases/handouts/presentation-handouts---cambi-eshowcase-2.pdf

3 https://www.cambi.com/resources/blog/sludge-dewatering-how-does-thermal-hydrolysis-improve-dewaterability/#:~:text=As%20thermal%20hydrolysis%20disintegrates%20organics,final%20biosolids%20cake%20with%20dewatering.

4 https://www.wef.org/globalassets/assets-wef/2-resources/online-education/eshowcases/handouts/presentation-handouts---cambi-eshowcase-2.pdf

## Business case

Thermal hydrolysis of sludge helps address the following issues in WWTW facilities:

- Costs incurred and regulatory barriers around transporting and disposing of large volumes of sludge.
- Need for additional energy (heat or electrical) to aid the WWTW process.
- The hazard posed by the production and storage of large volumes of organic-rich, biologically active sludge.
- Issues with poor anaerobic digester efficiency and throughput.

| CONSIDER THIS TECHNOLOGY IF |
|---|
| The target WWTW has an existing (or planned) anaerobic digestion installation that would benefit from increased biogas yields and digester efficiencies. |

**BUSINESS CASE[5]:**

**Estimated costs of thermal hydrolysis addition to existing anaerobic digester:**

Unit capital cost: R1900-R2 400 per tonnes dry solids treated

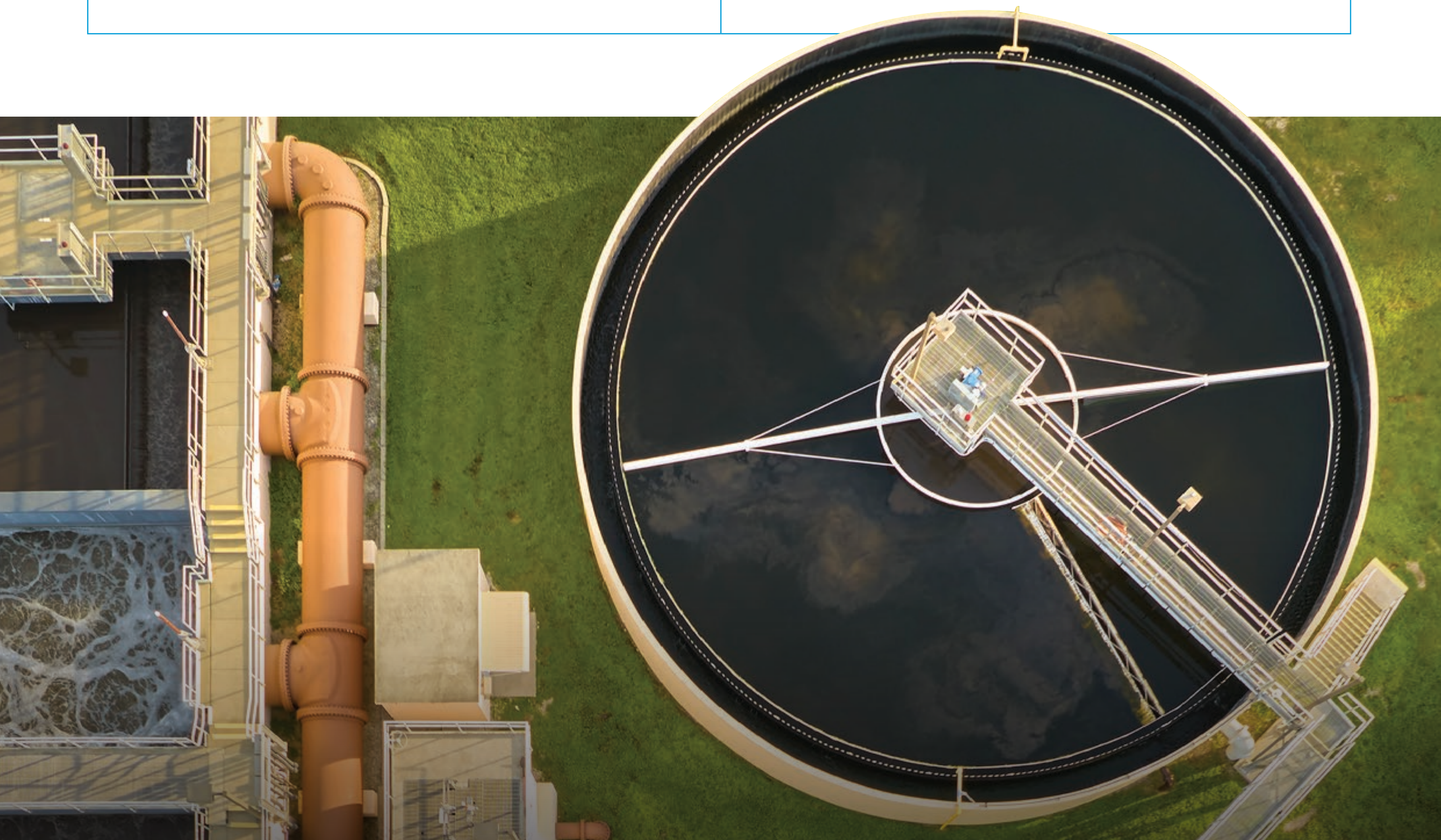
Unit operating cost: R6- R8 per kg dry solids treated[6]

Payback period: 2-5 years

Internal rate of return:31-53%[7]

**Potential benefits:**

- Increased digester throughput and efficiency.
- Reduced solid digestate mass.
- Increased dewaterability of AD sludge.
- Increased biogas (heat and energy) production.
- Reduced carbon footprint.



5 Based on international cost estimates, figures should be used as a guide.

6 Based on technoeconomic analysis of thermal hydrolysis addition to WWTW https://www.wrc.org.za/wp-content/uploads/mdocs/TT%20752-18.pdf

7 Based on technoeconomic analysis of thermal hydrolysis addition to WWTW https://tech4plus.com/publicaciones/hidrolisis-termica-tech4plus/7.pdf

# Financing mechanisms

Potential EE and RE 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<br>(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<br>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 feasibility/pre-feasibility studies to determine the expected technoeconomic performance of the addition of thermal hydrolysis to WWTW plant.
- Determine suitable financing mechanism for the project.
- Begin the process of planning, technical design, procurement, risk management etc. of thermal hydrolysis installation.

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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