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FACTSHEET

COMBINED HEAT AND POWER: AN OVERVIEW FOR PROJECT DEVELOPMENT IN WASTEWATER TREATMENT PLANTS

There is a growing interest among municipal entities operating wastewater treatment plants (WWTPs) to improve the energy and operational efficiency of these facilities. This is prompted by the need for municipalities to cut costs and contribute to global and national efforts to reduce greenhouse gas (GHG) emissions.

The uptake of combined heat and power (CHP) technology in South Africa's energy sector has been slow in both the public and private sectors. Within municipal WWTPs, slow uptake can be attributed to barriers like high initial capital costs, the current economic and regulatory environment, weak environmental policies, lack of political will, and poor infrastructure. These issues make it difficult to develop financially viable anaerobic waste treatment and CHP projects. On the other hand, some barriers have been created by less experienced project developers and could be overcome if projects are structured correctly.

This factsheet provides municipalities with recommendations on the processes and procedures to follow in developing a retrofit CHP plant operating on biogas within South Africa's municipal WWTPs.

1. IDEAL DESIGN AND STRUCTURE

It is recommended that to achieve financial viability for the development of CHP projects at WWTPs, all critical sludge train processes should be integrated in the CHP process to maximize the methane (CH4) yield, and therefore, power generation.

An example of the critical sludge train processes that should be included is shown in the diagram below. The example is based on the process design of the City of Tshwane's Zeekoegat WWTP.

This is part one of a four-part factsheet series based on lessons learned from a feasibility study and project development process for a combined heat and power project at the City of Tshwane's Zeekoegat Wastewater Treatment Plant and existing projects at the City of Johannesburg and eThekwini Municipality.

The following factsheets and additional resources in this series can be found on Climatelinks.org.

- Ideal Design & Structure
- Project Development
- Project Procurement
- Case Study
- CHP GHG Calculator

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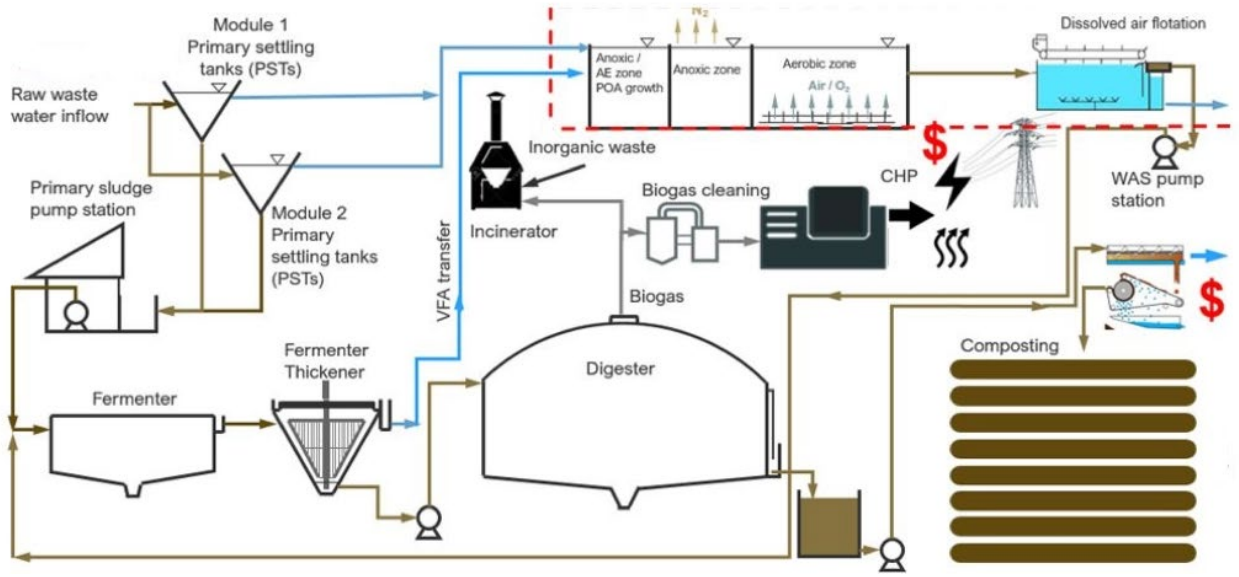


An example of the critical sludge train processes.

Financial viability of the CHP project could be further improved by converting dewatered sludge into an industrial organic fertiliser, as well as selling renewable energy certificates (RECs) into the voluntary South African market, as happens in the United States.[1]

To achieve full financial viability, it is recommended that certain critical elements should be "ring-fenced" and placed under the full control of the anaerobic digester and combined heat and power (AD/CHP) operator, i.e.:

- ✓ Feeding of the digester, i.e., feeding frequency, the total solids content of the feedstock, and consistent composition of the feedstock.
- ✓ All wastewater sludge should be digested for maximum biogas generation – therefore, all waste activated sludge (WAS) and primary sludge should be aerobically treated.
- ✓ Controlled mixing of the anaerobic digester to maintain the digester at the correct pH.
- ✓ Dewatering and thermal stabilisation of the digestate.

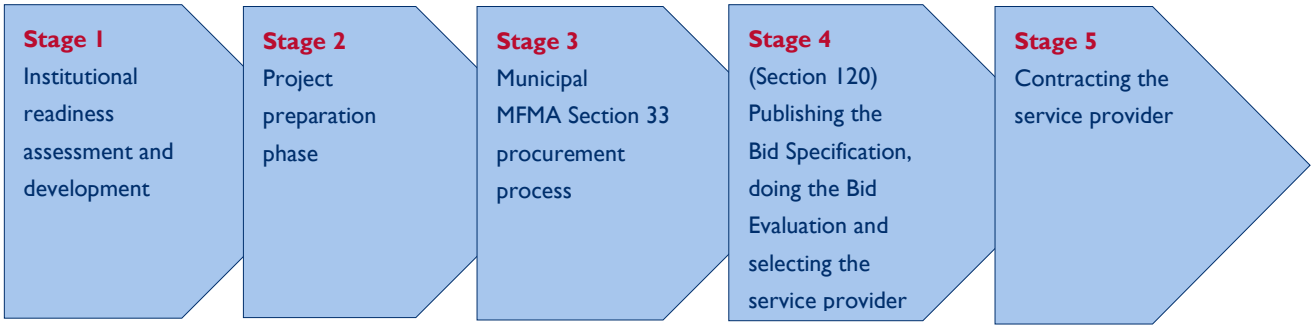
[1] A renewable energy certificate, or REC (pronounced: rĕk), is a market-based instrument that represents the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource. zaRECs (Pty) Ltd. administers the South African voluntary Renewable Energy Certificate (REC) market along the lines of the European Energy Certificate System (EECS) specifications on behalf of members of the voluntary Renewable Energy Certificate South Africa market participant's association (RECSA).

2. PROJECT DEVELOPMENT PROCESS

AD/CHP projects address wastewater treatment, independent power production and renewable energy objectives that should be included in the Municipality's Integrated Development Plan (IDP). The municipal officials that wish to develop AD/CHP projects will have to ensure that these objectives are included in annual performance plans or relevant internal planning processes, in order to support the project development process.

AD/CHP projects require highly specialised technologies, and municipalities should consider long-term "design, build, operate, and maintain" – "DBOM" project structures – in order to optimise the performance of such plants and mitigate risks.

It is suggested that such projects should be developed in five stages, as follows in the diagram below:



A project team should be established to carry out the operational project development activities and report to a steering committee to ensure that the project maintains its strategic intent. The steering committee should be represented by municipal departments that will be impacted by the project and that will contribute to the municipal council approval process.

The project team should be led by a suitably qualified individual (or champion), with the authority and decision-making responsibility to ensure the project team works together across municipal divisions. This champion should be able to drive, manage, and coordinate the internal processes and communicate effectively.

The project team should initiate a series of evaluations to determine the level of technical and financial viability that could be achieved with AD/CHP projects in the municipality, and more specifically at the WWTPs. The team will present its findings to the steering committee, which will recommend whether AD/CHP projects should be considered, and if considered, which projects should receive priority.

The procurement process should be aligned with the municipal financial management and accountability cycle, as outlined in the "Local Government Budgets and Expenditure Review" published by National Treasury.

3. PROCUREMENT

CHP plants have an expected lifespan of seven to 10 years depending on the technology used, and the municipality may therefore need to have a contract for at least the expected lifespan of the critical electricity generation equipment.

Therefore, a long-term project that aims to reduce the technical and financial risks to a municipality and increase the affordability will extend the project's financial obligations beyond the three years covered in the annual budget process.

To enter into a contract of over three years the municipality will have to follow the prescribed process under Section 33 of the Municipal Finance Management Act (MFMA).

Competitive procurement, including Public Private Partnerships (PPPs), must also comply with Section 120 of the MFMA and the following:

- ✓ **Bid Specification**: This is informed by the outcome of the feasibility and council resolution.
- ✓ **Bid Evaluation**: The comparative evaluation of bids received against the bid specification.
- ✓ **Bid Adjudication**: The Supply Chain Management Department strictly administers this process and no interference by any other individual is allowed in this process.

A project pre-feasibility or scoping of the potential WWTP site should be done prior to performing a bankable feasibility[2] analysis, i.e., determining the suitability of a site for AD/CHP project development, which will include an infrastructure audit and testing the sludge for its biogas potential.

A strong technical and financial development team should be established for both the pre-feasibility and bankable feasibility studies. If the skills and experience are not available within the municipality, budget needs to be made available to appoint external individuals to strengthen the team. Additional support could also be provided by external agencies or organisations.

Bid Specification. It is recommended that the procurement process should not follow the traditional method of design-bid-build[3] ("DBB"), i.e., the municipality does not have to design and produce bid documents, including construction drawings and technical specifications, on which various general contractors will, in turn, bid to construct the AD/CHP project. It is proposed that these projects adopt performance-based contracting, where the contractor is tasked with undertaking and assuming the risk

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[2] A feasibility study is an engineering study based on test work and engineering analysis, which presents enough information to determine whether or not the project should be advanced to be final engineering and construction stage.

[3] In the DBB system, the municipality appoints an independent team of consultants on a fee basis, who completely designs the project and prepares tender documentation upon which competitive bids are obtained from the contractors. The successful tenderer enters into a direct agreement with the municipality and carries out the work in accordance with the design and specifications provided.

of designing the plant. This could be achieved through an Engineering, Procurement and Construction (EPC) contract whereby the municipality provides output specifications and have little input into the design. Compared to a DBB contract, where the municipality provides a high-level design outline that the contractor has to refine and detail engineer, under an EPC contract, the contractor is expected to provide performance guarantees of the completed facility. These models allow for flexibility to accommodate innovation by the bidders in terms of technologies to be considered. This approach will minimise technical and financial risks by increasing the affordability and reducing operational and maintenance risk to the municipality. It also creates an opportunity for the main contractor to sub-contract certain portions of the contract to other expert engineering companies.

Bid Evaluation. This could become complex if the bid specification includes the design phase as suggested above, as different contractors could offer equipment/plant options that are not technically or financially comparable. This could be countered by adding an additional layer of "Technical Evaluation" before the official municipal Bid Evaluation Committee (BEC) starts its process. A "Technical Bid Evaluation Team" should be appointed by the municipality to carry out a detailed technical assessment of the bid submissions, which should be coordinated by an experienced procurement practitioner (of the municipality) who must ensure that information is seamlessly transferred to the BEC. The team should be independent and highly experienced in all operational and maintenance processes and should also have the necessary financial modelling skills to evaluate the affordability of the project. The municipality should allocate a budget towards the appointment of the Technical Bid Evaluation Team, as it is unlikely that these highly specialised technical skills exist within the municipality, and time should be allowed in the project development process to identify and contract these specialist individuals.

Bid Adjudication. The Supply Chain Management (SCM) Department strictly administers this process and no interference by any other individual is allowed in this process.

Contracting. This will include the appointment of a transactional advisor, with primarily legal and contractual background. It is recommended that contracting is done in a multi-phase approach, i.e.:

1. To contract the design and build activities that could run for a period of one to two years, depending on the requirements of the bid specification, or to the point when a certificate of completion is issued.

2. Appoint the same contractor for a one-year operations/maintenance contract, which runs concurrently with a defect liability and repair period. However, municipal procurement may not allow simply appointing the same contractor – it will either be:

    a) three-year contract (one-year construction and two-years operations and maintenance) and any extension of this contract should be through a new Request for Proposal (RFP) risking a new entity managing the plant; or

    b) Section 33 process and enter into a long-term contract.

3. Operations/maintenance contract that will continue for the period that the municipality requires the AD/CHP project to be operational, minus the phase one and phase two periods of the contract.