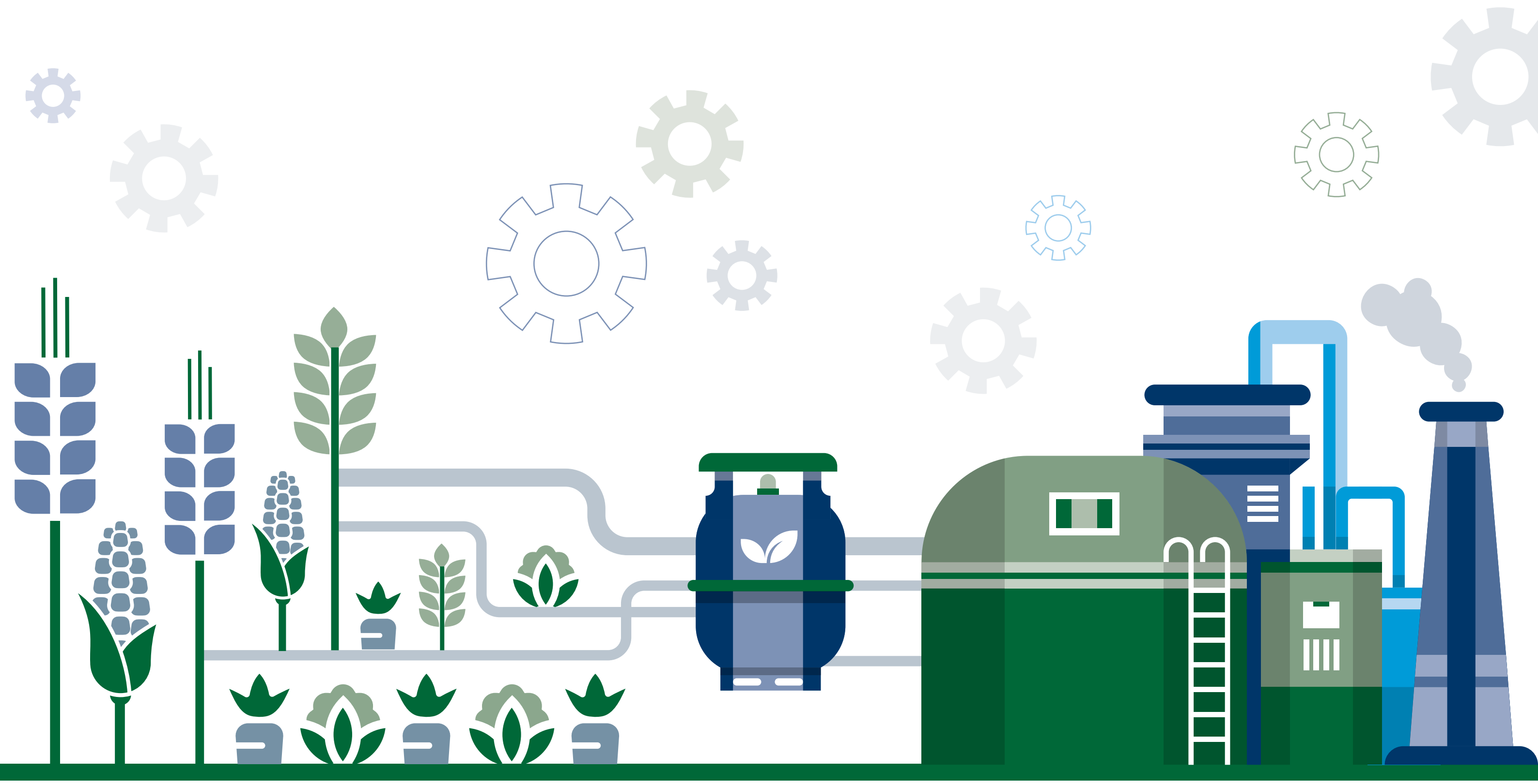
Biogas Guide

20 Years NCPC
INDUSTRIAL EFFICIENCY IN SOUTH AFRICA

UNIDO



A resource of the Industrial Energy Efficiency Project in South Africa

the dtic
Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

gef

1. Biogas Overview

Biogas is a source of energy and can be utilized in several ways. The most common applications are as a cooking fuel in domestic or rural applications or converted to electricity for industrial scale plants.

Biogas could however also be used for direct combustion to produce thermal energy in the form of hot water, steam raising, or space heating; but can also be upgraded to biomethane by extracting the methane and CO_2 from the biogas (both of which could become a source of income). The specific application of biogas is determined by the parameters of each individual project.

A biogas plant would not only be a source of renewable energy but will also make a significant contribution towards environmentally sustainable waste management, carbon mitigation and produce organic fertilizer as a waste product. The above is applicable to both small domestic scale digesters, as well as large industrial biogas plants.

2. How is Biogas Produced?

Biogas is produced when organic material decomposes in the absence of oxygen, referred to as anaerobic digestion (AD). During the AD process, bacteria digest the organic matter and generates biogas as a waste product. In the process between 30% - 60% of the digestible solids are effectively converted to biogas. AD is a natural process and essentially replicates the human digestion system.

A typical biogas plant would consist of an airtight vessel (digester), which is fed continuously with prepared organic waste slurry. The AD process removes most of the harmful pathogens and the effluent (digestate) produced has the potential to be used as an organic fertilizer.

Industrial digesters are normally heated and equipped with some form of mixing mechanism, both of which improves the efficiency of the AD process. Heating and mixing do not normally occur on a small-scale installation due to the high associated running cost. Biogas produced at this scale is typically converted to electricity, used to generate thermal energy (hot water, steam, space heating) or upgraded to biomethane.

Figure 1 shows a diagrammatic layout of a typical industrial biogas plant which essentially consists of four components: feedstock preparation, the actual digester, biogas implementation and digestate management.

All biogas plants will contain each of these four components, although the detail of each will be determined by factors such as type of feedstock, the chosen digester technology, what the biogas generated will be used for and how the digestate will be processed, stored, and disposed of.

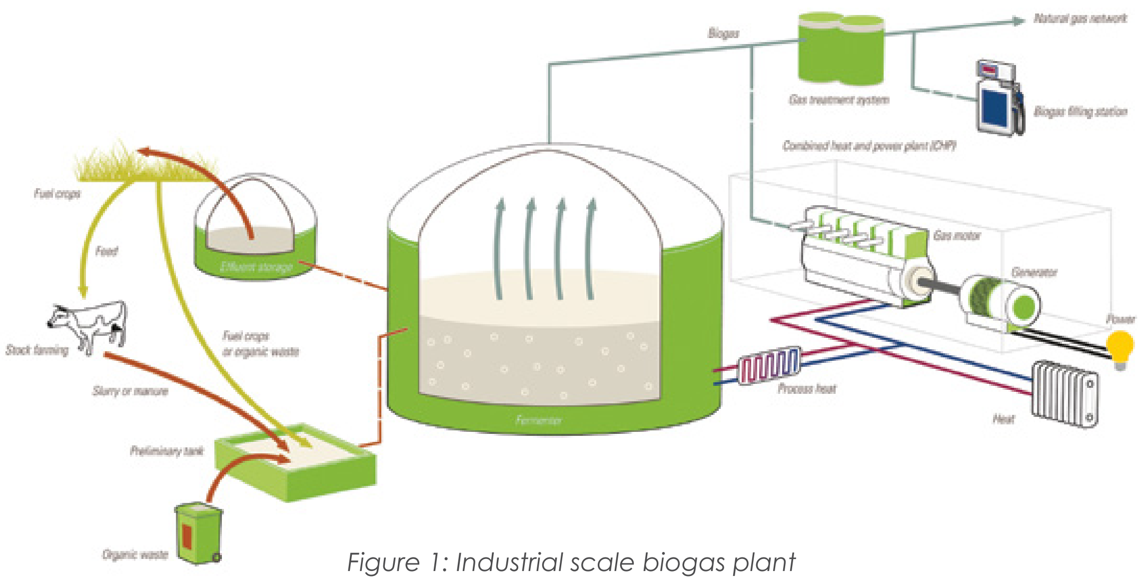
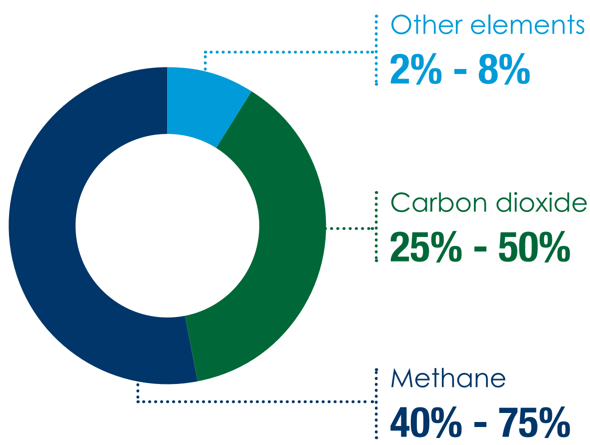


Figure 1: Industrial scale biogas plant

Biogas consists predominantly of methane (CH_4) and carbon dioxide (CO_2), with some additional trace gasses such as hydrogen sulphide, ammonia, water and other volatile organic compounds. Methane content varies from 40% - 75%, CO_2 from 25% - 50% and the other elements 2% - 8%. The most important component being methane, as it is a combustible gas, which can be used various applications similar to the more common LPG.

It is important to note that the amount of digestate produced is roughly equal in quantity to the amount of feedstock slurry fed into the digester – only the solids in the feedstock slurry is consumed by the microbes and converted into biogas. Biogas projects should therefore include practical and cost-effective digestate management as part of the initial planning process.



3. What are the main benefits associated with the development of biogas projects?

A biogas plant, whether on a small or large industrial scale, contributes favorably to environmental sustainability. It converts what is potentially an environmentally hazardous waste material to biogas as a renewable energy source and creates an organic fertilizer as a waste product. By capturing and combusting the biogas, methane (which would have entered the atmosphere from where material was decomposing) is effectively prevented from entering the atmosphere and thus contributes towards carbon mitigation. Methane is 22-30 times more harmful as a greenhouse gas when compared to CO_2.

Biogas plants further contributes towards environmental sustainability by diverting organic waste from going to landfill. Landfill space in South Africa is running out and municipalities such as the City of Cape Town have banned organic waste from being landfilled from 2027 starting with a 50% reduction in 2022. A large biogas industry could significantly contribute towards achieving sustainability goals for a country on a national level through sustainable waste management and carbon mitigation.

Many governments support the development of their biogas industries by providing grants, rebates and other forms of incentives for the benefits mentioned above. Such forms of support were critical in the development of all the major biogas industries around the world in countries such as China, Germany, Denmark, the USA and others. Support is critical for both industrial scale projects, as well as for the development of rural and domestic digester installations.

4. General approach in developing a project

The development of a successful biogas project depends on addressing several complex questions such as feedstock, biogas utilization, off-take agreements, digestate management, regulatory requirements, and financial viability indicators amongst others. Failure in any of these factors could render a biogas project not- feasible.

The most important component when developing a biogas project is the type and amount of suitable organic waste (feedstock) which could be secured on a continuous basis. The type and amount of waste would determine the size of the digester, the amount of biogas which could potentially be produced and ultimately the cost of the plant. These factors combined will determine the "first pass" viability of the project, both in terms of the direct financial return on investment, as well as the combined benefits the biogas plant would contribute towards the overall viability of the project.

Biogas projects requires significant capital investment and most financiers and/or investors would require a certain minimum return on investment (ROI). Projected income is normally primarily dependent on the sale of the energy derived from the biogas produced. This could be in the form of partial replacement of existing sources of energy (electricity, coal, diesel, LPG, etc.) or selling off-site to a third party. In some select instances income could be derived from the benefits associated with digestate as a fertilizer.

The deferred disposal cost of waste could contribute towards the financial viability of the biogas project since a biogas project processes waste on site which would normally incur a disposal cost if the waste was sent to landfill.

Other revenue streams that are not fully defined yet and should only be considered as a bonus benefit (not relied on as a primary revenue stream for the project) and includes possible indirect income that could be derived from carbon credits or by reducing carbon tax liability.

Proving overall viability for a biogas project, from either direct financial viability or a combination of the additional benefits associated with the development of a biogas plant, remains a challenge, especially where little or no financial incentives or support is available. A detailed feasibility study is essential before embarking on any biogas project.

In countries where financial incentives are available, it is generally not such a challenge to achieve an acceptable ROI, but this becomes a challenge where no such support is available. The latter is the current situation in South Africa, where the viability of biogas projects would need to rely entirely on the profit the project could show from the income generated by the plant.

The development of a biogas project depends on a host of variables, all of which could be critical in the final decision to proceed with the project.

The table below describes in essence the steps to follow in the development of a typical biogas project. The challenge is however that there is very little generic information about developing a biogas project and the steps identified should serve as a guideline only. The circumstances for each project would be unique and development parameters should be assessed on their own merits for each site.

Step	Activity	Description
1	**Assess feedstock**	Type, quantity, quality, availability, biogas yield potential. Long term supply security (contractual agreement).
2	**Secure energy off-take**	Electricity, heat, upgrade to biomethane or combination. On-site use or scale to 3rd party (wheeling/off-take agreement).
3	**Plan for digestate management**	Practical and cost effective disposal. Possible use as organic fertilizer. Liquid/solid seperation.
4	**Ensure regulatory compliance**	Environmental (EIA provcess). Possible grid connection (Eskom and/or municipal).
5	**Plant design**	Simplified choice of technology (consider local lack of skilled operators and high cost of maintenance). Suitable for type and quantity of feedstock (differs from European). Design for local conditions.
6	**Cost estimation**	Optimise plant cost to improve overall financial viability. Research companies with relevant local and international experience to assist with design and cost estimations.
7	**Determine project viability**	Define expectations of all stakeholders in terms of financial, as well as overall project viability. Determine project structure/ownership. Contractual arrangements.
8	**Project implementation**	Select suitably qualified and experienced contractor. Underdtand commissioning challenges (need for inoculation, 6-9 months required to stabilised AD process, no income during this phase). Need for experienced and skilled operator. Practical and contractual provision for long term maintenance.

5. Why is Biogas important and in which industries?

South Africa has recently recommitted to reduce greenhouse gas emissions in terms of United Nations Framework Convention on Climate Change (UNFCCC) and its Paris Agreement (PA). The South African Nationally Determined Contributions (NDCs) were approved by Cabinet in March 2021. A reduced dependency on coal was identified as one of the primary means by which to achieve this.

The development of a large biogas industry in South Africa has the potential to not only contribute towards the generation of renewable energy and thus replacing coal, but also in achieving general sustainability goals set on a national level in terms of waste management, carbon mitigation, diversion from landfill and job creation within the green industry.

Biogas also has the advantage that it can be stored, which allows for energy usage during periods when other renewable energy sources such as Solar PV is not available (at night).

The best opportunities for the development of biogas projects are with industries generating large quantities of organic waste such as abattoirs, food processing plants and livestock farming (dairies, feedlots, piggeries, chicken farming). Municipalities also presents great opportunities at the wastewater treatment works (sewerage sludge), as well as processing the separated organic fraction of municipal solid waste (OFMSW).

6. Useful tools and Training

A few calculation tools are available to assist with providing initial project parameters. These tools serve as a handy guide during the initial development phase but should not serve as the final design or cost estimation for the project. There are simply too many variables unique to each project, each of which could significantly affect the results produced by such tools.

a) Global Methane Initiative: **https://www.globalmethane.org/resources/details.aspx?resourceid=5170**
b) Biogas World: **https://www.biogasworld.com/biogas-calculations/**
c) BioWatt: **https://biowatt.org/biogas-calculator/**
d) KTLB: **https://daten.ktbl.de/biogas/startseite.do?zustandReq=1&selectedAction=showMona#start**
e) Biogas substrate biogas yield potential: **https://www.lfl.bayern.de/iba/energie/049711/index.php**

The biogas industry is still in its early development stages and does not offer many training opportunities for either developers, financiers, or operators. The NCPC-SA has however recently developed a comprehensive set of accredited training courses which provides an excellent opportunity for interested parties to improve their understanding of all aspects of biogas, from understanding basic biogas principles, to the actual step by step development of a biogas project.

Courses include the following:

a) Biogas End User Course
b) Biogas Expert Course

Notes

20 Years NCPC
INDUSTRIAL EFFICIENCY IN SOUTH AFRICA

UNIDO

Contact us

Tel: + 27 12 841 3772

Email: ncpc@csir.co.za

www.ncpc.co.za

the **dtic**
Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

gef