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**Evaluation Report:
Promoting Organic Waste-to-Energy and other
Low-Carbon Technologies in Small and Medium and
Micro-Scale Enterprises (SMMEs). Accelerating
Biogas Market Development in South Africa**

Office of Evaluation and Internal Oversight

**OFFICE OF EVALUATION AND INTERNAL OVERSIGHT
INDEPENDENT EVALUATION UNIT**

**Independent Evaluation of a project:
Promoting organic waste-to-energy and other low-carbon
Technologies in small and medium and micro-scale
enterprises (SMMEs):
Accelerating biogas market development in South Africa**

**Project ID: 130310
GEF Project ID: 5704**



**UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION**

Vienna, December, 2023

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Abstract

The project, supported by the Global Environment Facility (GEF) and implemented by the United Nations Industrial Development Organization (UNIDO), aimed to promote renewable energy and reduce greenhouse gas emissions through the conversion of waste to biogas. The evaluation assessed the project's overall attainment of objectives, sustainability measures, and scalability. The findings indicate that the project was well-designed and aligned with GEF objectives. It successfully engaged stakeholders and promoted market shifts towards renewable energy investments. Financial management and co-financing were appropriately reported and monitored, demonstrating the viability and interest in waste-to-energy activities in South Africa. The project generated valuable knowledge and documents to support future biogas projects. Although some output targets were not fully achieved, significant progress was made, including the installation of biogas plants and reduction of greenhouse gas emissions. Overall, the project managed to positively change the view point on biogas projects towards environmentally sound resource management and was therefore rated as overall moderately satisfactory.

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Furthermore, we would like to express our gratitude to all stakeholders at Department of Forestry, Fisheries and the Environment (DFFE), Department of Mineral Resources and Energy (DMRE), Southern African Biogas Industry Association (SABIA), the University of Venda (UNIVEN), North West University (NWU) and the University of South Africa (UNISA) and all the Experts and Industries, who provided valuable insights, shared feedback and resourceful learnings from WtE project. Finally, thanks to UNIDO’s Independent Evaluation Unit for their support and guidance throughout the process.

Evaluation team:

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Abbreviations and Acronyms

Abbreviation	Meaning
AD	Anaerobic Digestion
ARC	Agricultural Research Council
BAT	Best Available Technologies
CSIR	Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development (former DAFF)
DBSA	Development Bank of Southern Africa
DEA	Department for Environmental Affairs (now DFFE)
DFFE	Department of Forestry, Fisheries and the Environment (former DEA)
DMRE	Department of Mineral Resources and Energy (former DOE)
DoE	Department of Energy (now DMRE)
DTIC	Department of Trade, Industry and Competition (former DTI)
DSBD	Department of Small Business Development
DSI	Department of Science and Innovation (former DST)
EE	Energy Efficiency
EW-SETA	Energy and Water Sector Education and Training Authority
GEF	Global Environment Facility
GHG	Greenhouse Gases
IDC	Industrial Development Corporation
IPAP	Industrial Policy Action Plan
NDP	National Development Plan
NEMWA	National Environmental Management Waste Act
NCPC	National Cleaner Production Centre
NPC	National Project Coordinator
NSSD	National Strategy for Sustainable Development and Action Plan
NWU	North-West University
MCEP	Manufacturing and Competitiveness Enhancement Programme
MTR	Mid Term Review
PFP	Project Focal Point
PMU	Project Management Unit
PER	Pressure Equipment Regulation
PSC	Project Steering Committee
SA	South Africa
SABIA	Southern African Biogas Industry Association
SABS	South African Bureau of Standards
SANEDI	South Africa National Energy Development Institute
SARETEC	South African Renewable Energy Technology Centre
SAQA	South African Qualification Authority
SAQCC	South African Qualification and Certification Committee
SETA	Sector Education and Training Authority
TE	Terminal Evaluation

ToC	Theory of Change
TOE	Tons of Oil Equivalent
TORs	Terms of Reference
ToT	Training of Trainers
TVET	Technical and Vocational Education and Training
UNEG	United Nations Evaluation Group
UNIDO	United Nations Industrial Development Organisation
UNIVEN	University of Venda
WtE	Waste-to-Energy

Executive Summary

The Waste-to-Energy Project (WtE) was supported by US\$ 4.222.110 from the Global Environment Facility (GEF), with the project proposal indicating that WtE counterparts and beneficiaries would provide a further 41,884 million in co-financing (cash and in-kind). UNIDO served as the GEF implementing agency, supporting project oversight and providing technical inputs where required. WtE was guided by a Project Steering Committee (PSC), chaired by Department of Forestry, Fisheries and the Environment (DFFE) (former DEA) and UNIDO, including Department of Mineral, Resources and Energy (DMRE) (former DOE) being the co-chair, as well as Southern African Biogas Industry Association (SABIA); Department of Trade, Industry and Competition (DTIC), and other relevant Government Departments.

This assessment spanned the project's activities commencing on March 1, 2016, which denoted the initiation of practical implementation, and extended through September 30, 2023. The official project start date was the 1st (first PSC meeting) and commenced with Waste-to-Energy Launch event in Hatfield, 3rd of February 2017. The project was initially scheduled for a duration of four years but experienced two extensions, ultimately persisting for a total of 7.5 years.

The main objective of the Terminal Evaluation (TE) was to assess the project's overall attainment of its primary objectives and the likelihood of their realization. Additionally, the assessment sought to quantify the project's incorporation of sustainability and scaling-up parameters, thereby augmenting its efficacy in fostering sustainable outcomes and broader societal influence.

Key Findings

The project was well designed and the strategies to promote Renewable Energy (RE) and waste to energy to reduce greenhouse gas (GHG) emissions are still valid and highly needed. It aligned with the Climate Change Focal Area Objectives 2 and 3 of the GEF-5 which are centered on fostering market shifts conducive to investments in renewable energy and low-carbon technologies. It promoted the introduction of selected renewable energy (RE) technologies in South Africa, especially the conversion of waste to biogas and the use of digestate as a fertilizer represents an environmentally responsible approach to resource management aimed at mitigating GHG emissions.

The project was relevant to the target group and project stakeholders. The multi stakeholder approach and the high number of workshops, technical meetings, trainings and expert discussions created a strong sense of ownership to the project results among the national stakeholders.

UNIDO project management team (with support from Headquarters) appropriately reported financial information. Changes to fund allocations as a result of actual planning and budget revisions took place, and had been jointly agreed, documented properly and were appropriate. Co-financing from industries, government and financial institutions was significant. Monitoring scheme for co-financing was done in detail, the latest figures showed the total co-financing of USD 42.82 million, most of it coming from those units (project developer/ owner and respective finance institutions) that received direct support from the project. These figures showcase the viability and high interest in WtE activities and investments in South Africa.

The WtE project – by learning from success stories and (more important) failures - has developed multiple valuable documents that will support future biogas projects and therefore successfully supported the “...market-based adoption of integrated biogas technology in small and medium and micro-scale enterprises in South Africa...”.

It has not only proven the high value of digestate (to be used from local households, farmers up to mine rehabilitation), but also changed the view point on biogas projects as such. From conversion of waste into energy (either electricity or heat), it is now seen as a tool for environmentally sound resource management and an important part of a ‘circular industrial economy’.

Project efficiency is rated moderately satisfactory. At time of the TE mission around 97% of project funds, i.e., USD 4,101,644.11 was spent, the open budget was planned to be utilized for remaining activities (i.e. closing and handover event).

Project effectiveness is rated moderately satisfactory; A significant proportion of output targets have not only been met, but also exceeded, and notable advancements toward the realization of most desired outcomes have already become visible. Even though none of the 5 demonstration plants (outcome 3.2) was fully functioning during TE visit (see details under efficiency, output 3.3.), WtE could support the instalment of 4,3 MW_{el} and 1,96 MW_{thermal}.

WtE has already contributed to direct and indirect GHG emission reduction (see output 4.2) and Biogas plants leading to lifetime savings (i.e. 20 years) of 711,333 tCO_{2eq.}¹ and will do more in future.

With this said, the **overall rating** can be stated to be **moderately satisfactory**.

The rating of the key evaluation criteria is summarized in the Rating Table 1 (next page), the details for the rating are given in Annex 3 (Progress towards expected results based on the on Project Log Frame and rating table).

Key Conclusions

Overall, an enabling environment conducive to the adoption of WtE and low-carbon technologies has materialized, with numerous stakeholders involved in the WtE project expressing keen interest in backing its future endeavors. But, the classification of these projects under specific domains (Energy, Environment, Agriculture, Development, SMME) remains still unclear. None of the involved government entities is willing to take up leadership. Consequently, the grant schemes and subsidies under which they fall remain uncertain, leading to restricted access to financial support.

Based on detailed feedback from project stakeholders and the evaluator’s own findings, the following recommendations are made, with a view to informing the design and strengthening of future UNIDO’s initiatives.

Key Recommendations

Recommendation 1:

Future projects on use of WtE by-products (slurry and/or dry products) in South Africa should tap into mining rehabilitation funds.

¹ The GEF tracking tool was shared after the TE mission only; a detailed verification of the calculation was not possible.

Recommendation 2:

UNIDO to clarify the importance of the GEF tracking tool and respective responsibilities and to develop a standardized method on calculations for GHG emission reduction and to support local project teams to fill the GEF tracking tool correctly.

Recommendation 3:

SABIA to compile a list of knowledgeable and trust-worthy suppliers and technical consultants for WtE (for household and use in SMME).²

Recommendation 4:

SABIA and research institutes/universities with help of government departments to work on models that factor in health improvement, skills development and support of local communities and food security aspects - to convert these factors into 'monetary terms' to support financial institutions and potential investors as well as to facilitate formulation of 'sustainable' policies.

Recommendation 5

Government entities, in collaboration with research institutions, should consider adopting the concept of "payment for environmental services (PES)" and ground it on the findings from the aforementioned research endeavors. This approach should not be limited to waste or disposal regime, but may encompass assessments of its social implications, such as health benefits and employment opportunities.

² During presentation of preliminary findings in SA, it was discussed, that SABIA is already working on a specific database.

1. Introduction

The Waste-to-Energy (WtE) project (hereinafter referred to as “WtE” or “the project”) initiated its operations on January 14, 2016, marked by the signing of the endorsement document, and continued through to September 30, 2023, with an overall duration of 92 months³. and commenced with Waste-to-Energy Launch event in Hatfield, 3rd of February 2017. The project included four main components as well as the project monitoring component.

The Project Management Unit (PMU) was set up by UNIDO being the GEF implementing agency supporting project oversight and providing technical inputs where required, ensuring adequate compliance with the project’s organizational structure and systems for facilitating implementation. The physical location for the PMU was the UNIDO Southern Africa Regional Field Office in Pretoria, South Africa.

WtE was supported by US\$ 4.222.110 from the Global Environment Facility (GEF), with the project proposal indicating that WtE counterparts and beneficiaries would provide a further \$ 41,884 million in co-financing (cash and in-kind). WtE was guided by a Project Steering Committee (PSC), chaired by Department of Forestry, Fisheries and the Environment (DFFE) (former DEA) and UNIDO, including Department of Mineral Resources and Energy (DMRE) (former DOE) being the co-chair, as well as Southern African Industry Biogas Association (SABIA); Department of Trade, Industry and Competition (former dti) (DTIC), DTIC (former **the dti**), Department of Agriculture, Land Reform and Rural Development (DALRRD) (former DAFF) deputised by Agricultural Research Council (ARC), Department of Science and Innovation (DSI) (former DST) deputised by Council for Scientific and Industrial Research (CSIR), and Department of Small Business Development (DSBD).

The project’s primary objective was to catalyse a market shift toward the utilization of organic waste from agriculture and agro-processing sectors for energy generation within Small, Medium, and Micro Enterprises (SMMEs). This goal was strategically planned to be realized by stimulating investments in waste-to-energy biogas ventures within SMMEs, facilitated through technology showcases, enhancement of data and knowledge resources, capacity development, and the reinforcement of policy and regulatory frameworks.

Table 2: Project fact sheet

Project Title:	Promoting organic waste-to-energy and other low carbon technologies in small, medium and micro enterprises (SMMEs) scale: Accelerating biogas market development in South Africa
GEF ID:	5704
UNIDO ID:	130310
GEF Replenishment Cycle:	GEF-5
Country(ies):	South Africa
Region:	AFR - Africa
GEF Focal Area:	Climate Change Mitigation (CCM)

³ The project was extended twice and got another extension to finalize it and perform the TE till end September 2023. Extensions were jointly agreed in PSC meetings

Stand-alone / Child Project:	Stand-alone
Implementing Department/Division:	ENE / CTI
Co-Implementing Agency:	
Executing Agency(ies):	Department of Forestry, Fisheries and Environment
Project Type:	Full-Sized Project (FSP)
Project Duration:	48 months
Extension(s):	3
GEF Project Financing:	USD 4,222,110
Agency Fee:	USD 401,100
Co-financing Amount:	USD 41,884.888
Date of CEO Endorsement/Approval:	1/14/2016
UNIDO Approval Date:	11/17/2015
Actual Implementation Start:	3/17/2016
Mid-term Review (MTR) Date:	7/01/2019
Original Project Completion Date:	3/17/2020
Project Completion Date as reported in FY21:	10/31/2022
Current SAP Completion Date:	9/30/2023
Expected Project Completion Date:	9/30/2023
Expected Terminal Evaluation (TE) Date:	8/30/2023
Expected Financial Closure Date:	9/30/2023
UNIDO Project Manager:	Mr. Alois Mhlanga

The following project components were developed to achieve the project objectives:

Project Component 1: Capacity building and technology support system

....was aimed to strengthen the institutional capacity as well as to address the insufficient technical capacity training, awareness, and the development of knowledge products, in support of risk of industry.

Expected Outcomes:

Capacity of market players and enabler strengthened, and biogas technology support system established.

Project Component 2: Biogas market development and regulatory framework

... focused on strengthening the regulatory framework to effectively promote and support SMMEs to invest in integrated organic waste-to-energy technology, focusing on quality standards, the use of digestate and grid connection.

Expected Outcomes:

Market environment strengthened and regulatory framework developed.

Project Component 3: Technology demonstration

....provided the technical feasibility and commercial viability to five selected SMME integrated biogas projects in different sectors and at different capacities by supporting their implementation.

Expected Outcomes:

Technical feasibility and commercial viability of waste-to-energy and other low-carbon technologies showcased

Project Component 4: Scaling up

...planned to support the establishment of a replication mechanism to mainstream the application of biogas for SMMEs by assisting additional biogas projects and helping to establish financial mechanisms targeted at promoting the use of integrated biogas technology.

Expected Outcomes

Investment to waste to energy and other low carbon technologies promoted.

Expected Outcomes:

Investment to waste-to-energy and other low carbon technologies promoted.

Project Component 5: Monitoring and Evaluation

....project management including M&E and knowledge management to ensure smooth project execution and uptake of the learnings. Project implementation to be monitored and evaluated on an ongoing basis during the project implementation.

1) monitoring and evaluation against the GEF's strategic indicators and 2) monitoring and evaluation project specific technical indicators for outputs per component.

Expected Outcomes;

Project's progress towards goals confirmed and/or necessary adjustments made. Knowledge disseminated.

1.1 Evaluation Purpose

The Terminal Evaluation (TE) was carried out as an independent in-depth evaluation using a participatory approach whereby all major key parties associated with the project have been informed and consulted throughout the evaluation.

The Evaluation Team (ET) comprised one International Team Leader and one National Evaluation Expert. The two team members were contracted by UNIDO for this specific evaluation. The team received logistical support (travel, interview scheduling, site visit support) from the UNIDO Headquarters and Southern Africa Regional Field Office.

The evaluation purpose and objectives, the theory of change, and the evaluative requirements of both UNIDO and the GEF all provided the basis for the evaluation framework, which in turn underpinned and guided the whole evaluation approach. The framework was structured against the standard OECD-DAC criteria agreed for the evaluation (relevance, coherence, efficiency, effectiveness, progress to impact, sustainability). The framework identified key evaluation questions, supported by guiding sub-questions. The full framework is presented in Annex 1, the six key evaluation questions are presented below:

1. **Relevance:** How relevant was the project to the needs and priorities of South Africa, and to the mandates of UNIDO and the GEF?
2. **Coherence:** To what extent was the project aligned with – and complementary to – other work being delivered in South Africa?
3. **Efficiency:** How efficient was the project's delivery?
4. **Effectiveness:** Did the project achieve its planned outputs and outcomes?
5. **Progress to impact:** How likely is it that the project's outputs and outcomes will contribute to long-term impacts?
6. **Sustainability:** To what extent are the project's outputs and outcomes likely to be sustained in the long term?

1.2 Evaluation Objectives and Scope

In line with its objectives, the first component focused on an overall assessment of performance of the project, whereas the second one focused on the learning from the successful and unsuccessful practices in project design and implementation.

The **primary target audiences** for the evaluation are:

- UNIDO management, particularly those with direct responsibility for the design and implementation of WtE and other projects with similar objectives on Waste-to-Energy projects.
- SABIA, experts and relevant Universities with significant influence on the dissemination, uptake and sustainability of any results achieved through WtE.
- DFFE and DMRE: DFFE as PSC chair and the GEF's focal point in South Africa, and DMRE as co-chair of PSC - both Ministries had integral roles in WtE delivery and future uptake and sustainability of any results achieved through WtE.
- The GEF Secretariat who continue to develop and deliver programs on the use of Waste-to-Energy globally.

1.3 Theory of Change

Theory of change (ToC) is a common management tool expressing the basic rationale behind an intervention. It describes the results an intervention aims to achieve, how the intervention works towards those results, and the main assumptions behind the intervention's approach. In turn, ToC also supports the identification of key elements that should be evaluated. As such, ToC is frequently used as the starting point for developing evaluation approaches, and for identifying evaluation questions.

While no explicit theory of change was formulated for this project, the project documents and the logical framework contain insights regarding identified obstacles, presumptions, and risks. This information aids in assessing whether the project's components and activities have been suitably crafted to achieve the objective of "Facilitating the market-driven adoption of integrated biogas technology within small, medium, and micro-scale enterprises (SMMEs) in South Africa.

The Evaluation Team has reconstructed the Theory of Change as presented under Annex 4.

The main conditions leading to the changes needed to achieve the project goals are:

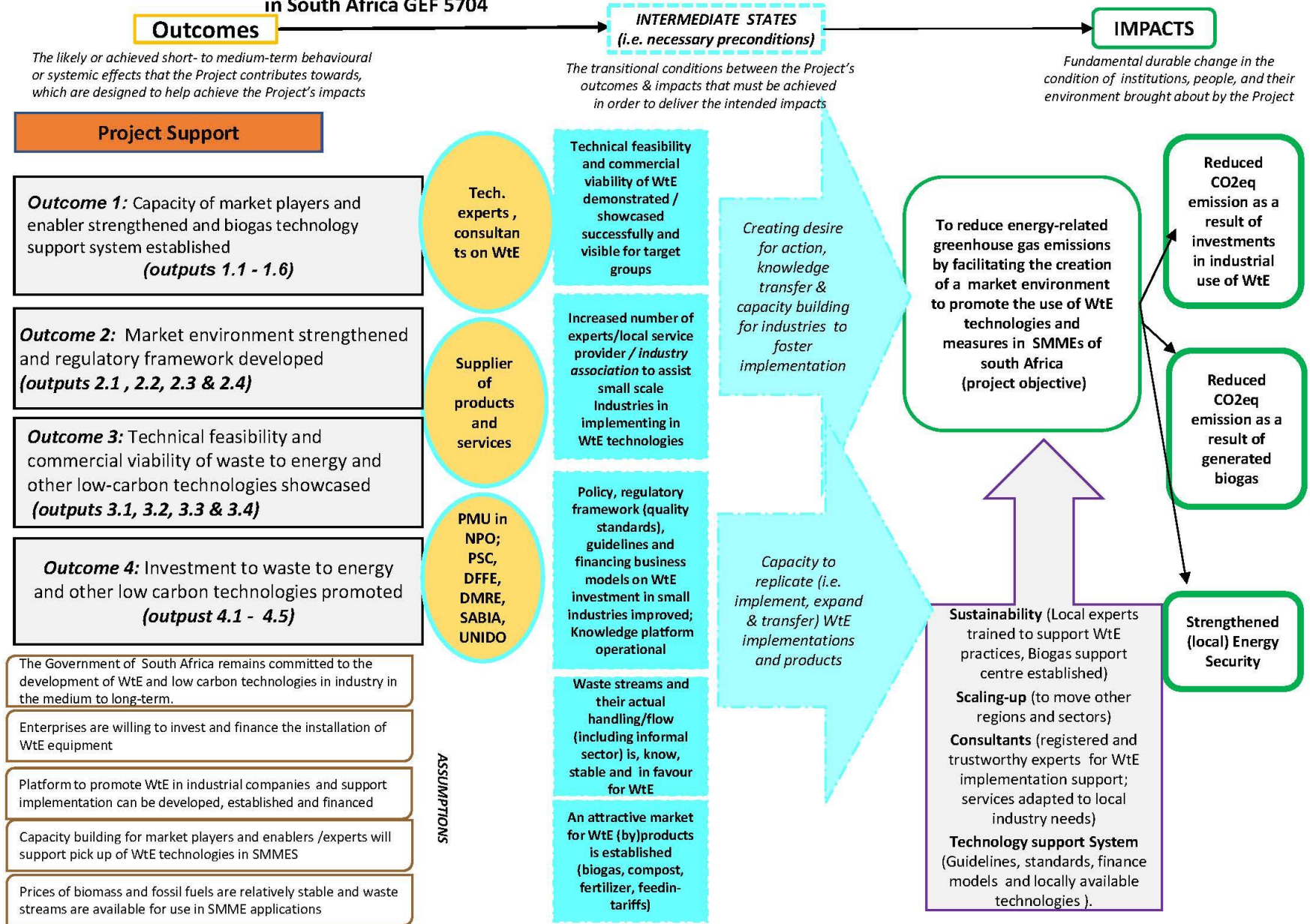
- (i) SMMEs will invest in WtE technologies, if:
 1. Enabling policies and regulatory framework (including financial and non-financial incentives and instruments) are in place;
 2. Investment platform to promote WtE is available, easily accessible and supportive for decision makers in SMMEs;
 3. Experts on WtE applications are locally available and reliable;
 4. Waste streams (=raw material for WtE) are identified, well known and stable and can be viably used to produce biogas and byproducts;
- (ii) Awareness among all relevant stakeholders can be raised;
- (iii) Effective capacity building will enable officials and WtE experts to provide efficient support locally.

The following main risks have been identified:

- **Implementation Risks:**
 - Lack of interest from SMMEs and project developers/technology provider to take up WtE projects;
 - Unsuccessful demonstration at selected sites due to, inter alia: Lack of capacity to operate and maintain biogas digesters; SMMEs go bankrupt; Fluctuation in waste availability and prices.
- **Political Risks:**
 - Lack of government commitment to support the project;
 - Change in national priorities leading to delays;
 - Reductions in the effectiveness of delivery of the project outputs.
- **Financial Risks:**
 - Incentives and financial support system are insufficient and delays in financing of investment projects due to lack of interest from enterprises may arise;
 - Industries' lack of resources to repay loans.
- **Technical Risks:**
 - Technology has a relatively high investment cost, and in the case of biomass also there can potentially be wide fluctuations in supply and price of the biomass resources and include operational risks;
 - WtE technologies do not succeed;
 - The technology may not perform as described mainly due to a lack of skills to operate the technologies;
 - Local experts and suppliers of equipment face limited experience and skills in consultancy and implementations.
- **Market Risks:**
 - Economic fluctuations and related market risks;
 - Low international oil and gas prices could make investments in biogas project unattractive.

Theory of Change reconstructed by ET, from INCEPTION REPORT GEF 5704 (next page)

Reconstructed Theory of Change – Waste-to-Energy in SMMEs in South Africa GEF 5704



1.4 Methodology

The evaluation employed a combination of research approaches to gather data and insights from various sources and individuals. Special emphasis was placed on cross-verifying the collected data and information prior to shaping its evaluation. Within this process, the Evaluation Team (ET) discerned the causal and transformative pathways linking project outputs to outcomes and enduring impacts, as well as the factors driving or impeding their realization.

In preparing this TE report, the ET reviewed the documentation of the project provided by the UNIDO's Project team, consulted key project stakeholders and conducted a 14-day field mission in South Africa to meet stakeholders, experts and the project beneficiaries and to discuss the results in detail with local stakeholders.

Overall evaluation team met 44 people (8 of them female) representing the main stakeholders and project beneficiaries.

Guided by the evaluation framework, the following common evaluation tools were applied to gather and analyse qualitative and quantitative information:

- **Interviews:** 44 individuals participated in interviews, mainly face-to-face discussions and a few remote meetings (via Zoom/Teams).
- **Site visits:** The ET visited 7 industrial Demo Sites and 6 household digesters in Limpopo, Gauteng, Free State and North West Provinces, and 7 visits at main stakeholder offices.
- **Desk review:** A comprehensive literature review considered all relevant documentation such as materials produced through the project (including mid-term review, progress reports, policy documents, technical guidelines, Steering Committee minutes and financial data), and relevant external documentation (including norms and legislation influenced by WtE).
- **UNIDO and GEF ratings:** All UNIDO evaluations are required to rate a series of evaluation and project criteria against a six-point scale, ranging from 'highly unsatisfactory' to 'highly satisfactory'. The project's ratings are presented in chapter 3 (mainly 3.3) and Annex 3 of this report.

1.5 Limitations

An actual database (names and mail IDs) to conduct a survey for trainees (government, technical experts, Youth) was not available. Therefore, the planned survey had to be dropped.

GEF focal point at DFFE was not in the country during TE visit, but a representative could meet the evaluation team on her behalf.

2. Project Background and Context

South Africa has one of the largest and most developed economies in Africa. Its GDP, as measured by purchasing power parity (PPP), ranks it as one of the top economies on the Continent. It contributes significantly to Africa's Gross Domestic Product (GDP), accounting for 24% of the total. This places South Africa in the category of upper-middle-income economies. The South African economy is diverse, with key sectors including mining, manufacturing, agriculture, finance, and services.

In 2017, South Africa ranked within the top 10 global producers of hard coal and in 2019, coal accounted for about 75 % of total primary energy supply and 88 % of electricity generation which has been a critical part of South Africa's economy for decades. Coal mining contributes 2.3 % to South Africa's GDP with 40 % to 45 % of the sales income attributable to the export market, namely to India, Pakistan and South-East Asia.

Similar to other coal-mining regions, the production and utilization of coal in this country gives rise to various environmental issues, including land fires, the generation of Coal Combustion Wastes (CCW), the release of toxic substances from coal, and the occurrence of Acid Mine Drainage (AMD). Furthermore, South Africa stands as a significant contributor to GHGs, responsible for approximately 65% of all emissions across the African Continent.

The national power utility in the country, Eskom, holds a dominant position in the electricity sector and is a state-owned entity. Nonetheless, because of a shortage in government investment, Eskom is unable to maintain its production at maximum capacity, given the increase in population and economic growth. Consequently, there has been a significant energy shortage, which led to the energy crisis. As a result, the nation now grapples with inherent obstacles that hinder economic growth, including skills shortages, decreasing global competitiveness, and recurrent work stoppages due to labour strikes. The government, in response, encounters demand from urban constituents to enhance the provision of fundamental services in low-income neighbourhoods, foster employment opportunities, and make higher education more affordable.

Biogas Technologies for South Africa

Biogas technology in South Africa presents a substantial potential capacity of 2.5 GW for electricity generation, with an estimated market value of around R10 billion. This has the potential to create numerous job opportunities within the country. Over the past few decades, there has been a notable increase in the participation of both governmental and non-governmental organizations in various biogas-related programs and initiatives. Organizations like the South Africa National Energy Development Institute (SANEDI) and SABIA are actively engaged in guiding, overseeing, and conducting innovative research within this sector. They collaborate closely with science councils and academic institutions across the country to advance this technology which has a huge potential to benefit agro-processing sectors, rural communities, unemployed youth and other marginalized groups.

In 2011, the Department of Energy (now referred to as the Department of Mineral Resources and Energy) published the Integrated Resource Plan (IRP) 2010-2030, outlining a long-term strategy for electricity generation. Within this IRP, the South African government established a target of achieving 20,000 MW of capacity from renewable energy sources by 2030. However, the IRP primarily emphasizes the use of solar PV for embedded generation, as it is deemed the "most probable form of generation to be embedded". Furthermore, the slow adoption of biogas as a desirable renewable energy technology is attributed to the

absence of incentivizing mechanisms, a reliance on non-sustainable energy sources, and the historical precedent of low electricity pricing.

In order to explore potential solutions for the biogas adoption challenge, the second National Biogas Conference took place in early March 2015 in Gauteng. This event was coordinated by a Conference Planning Team comprising stakeholders impacted by biogas policy and regulatory frameworks and investment perspectives as well as stakeholders with potential resources to engage in the resolution of the issue at hand these included GIZ, SABIA, IDC, UNISA, DoE and DEA

The potential for utilizing anaerobic digestion (AD) or biogas technology for the treatment of agro-processing waste in South Africa is substantial, yet its application remains notably limited. In a broader context, biological Waste-to-Energy (WtE) technologies in South Africa have predominantly centred around the extraction of methane gas from landfills and water treatment facilities. It's worth noting that only a handful of municipalities in South Africa are actively generating electricity through landfill gas processes. Among these, larger metropolitan municipalities like Johannesburg, Durban, Tshwane, eThekweni, and Ekurhuleni are at varying stages of planning, construction, and implementation of these WtE projects. Most of the significant AD projects established thus far are situated within wastewater treatment facilities and/or utilize sewage and organic municipal solid waste (MSW).

The biogas sector in South Africa is currently in an early stage of development and confronts a set of prevalent challenges, characterized by Financial and Economic Hurdles, Market and Awareness Limitations, Regulatory and Institutional Constraints and Technical and Infrastructural Obstacles.

Project Context

The primary objective of the *"Promoting organic waste-to-energy and other low carbon technologies in small, medium, and micro enterprises (SMMEs) scale: Accelerating biogas market development in South Africa"* Project was to advance the market-driven adoption of integrated biogas systems in areas with significant potential for harnessing energy from organic waste. This would be ideally realized through co-digestion, which involves the simultaneous treatment of organic residues from various sectors. To achieve this objective, a multifaceted approach would have to be employed, encompassing regulatory enhancements, market development initiatives, and targeted investments.

Enhancing the capabilities of market participants and facilitators has been a primary focus. Historically, the spotlight in South Africa was primarily on large-scale industries, along with small projects below 250 kW and individual households or communities. What distinguishes this project is its emphasis on promoting these technologies within the Small, Medium, and Micro Enterprises (SMMEs) sector.

Without the intervention of the GEF, the widespread adoption of these technologies in SMMEs, even in cases where there are ample and suitable organic waste streams and companies can demonstrate financial viability, would have been unlikely. This project serves as a catalyst, initiating demonstrations and expediting the replication of biogas technologies. Building upon previous GEF initiatives led by UNIDO, it aligns with other proposed GEF projects to address a critical sector that was previously overlooked. Furthermore, the project collaborates with ongoing projects and programs facilitated by various development partners.

3. Findings

3.1.Relevance

At the time of project design (2015) a baseline line assessment had been conducted earlier suggesting that limited knowledge and information were available on WtE for smaller application (below 250 kW) due to the following factors;

- Lack of awareness about the usefulness of WtE as a powerful low carbon technology.
- Lack of capacity and resources in sector associations for collecting and distributing reliable data/ information from their members.
- Lack of clarity on which regime or government department's WtE falls.
- Therefore, very limited interest from FIs and private sector to tap into the risk to finance WtE projects.

The Integrated Resource Plan (IRP) 2010-2030 by DMRE established a target of achieving 20,000 MW of capacity from renewable energy sources by 2030, primarily emphasizing/prioritizing the use of solar PV for embedded generation, as it is deemed as the "most probable form of generation to be embedded". DMRE still seems to rate Biogas as their lowest priority on Renewables.

On the other hand, there is the huge potential capacity of 2.5 GW for electricity generation and additional benefits from sound waste management (reduced pollution level), mitigation of unwanted methane emissions and use of digestate in agriculture, that justify the support given by this GEF/UNIDO project.

African leaders that attended the Africa Climate Summit 2023 (the Continent's first-ever climate summit - held in Nairobi, Kenya), stressed the importance of decarbonizing the global economy for equality and shared prosperity. They called for investment to promote the sustainable use of Africa's natural assets for the Continent's transition to low carbon development and contribution to global decarbonisation. The outcomes of this important meeting, that took place during the last month of WtE project shows the high relevance of further exploring and supporting low-carbon technologies in (South) Africa.

The **project relevance is rated satisfactory**, on account of high relevance in terms of target group and overall objectives, and overall relevant project logic and design. It gave the much-needed support for awareness creation and to promote WtE as low carbon technology in the country, but with the shortcoming, that till today no governmental entity is taking up the leading role.

Relevance of the project design

The original project design was to create awareness and understanding of WtE implementations. To support the local Biogas association and to showcase global best practice in South Africa was and still is highly relevant to the country context. Most of the project outputs and activities were in line with South African Government priorities as well as with UNIDO's and GEF's focus on SDG 9 and 7 and GHG reduction. The design fitted the actual needs of the country in 2016, but had to be adapted to actual needs, e.g., several of the planned projects for Biogas plants had to be dropped due to various changes in their respective circumstances.

The multi stakeholder approach and the high number of workshops, technical meetings and expert discussions created a strong sense of ownership for project results among the national stakeholders. They also led to enhanced relevant stakeholders' knowledge and

awareness of WtE, enhanced waste management, use of digestate and low-carbon technologies. Industries did not have the resources and the knowledge to conceive and implement WtE projects by themselves and very few credible local best practice examples existed.

The project was designed appropriately by involving all key stakeholders. The design of the project was adequate to address the energy problems (power shortage, grid problems, high CO_{2eq} per kWh electricity produced) in South Africa. It met the needs of the target groups to a greater extent, and was consistent with UNIDO's inclusive and sustainable industrial development. The project approach applied was appropriate, and the design was technically feasible and based on best practice. The institutional and implementation arrangements as mentioned in the project document were valid and relevant.

The combination of showcasing technologies for WtE and their viability under local conditions (Component 3) and upscaling (Component 4) with technical training and awareness raising (Component 1) to further utilize and maintain these technologies are proven approaches and worked well in South Africa.

One shortcoming in the design phase was the focus and reliance on a few (preselected) industrial companies. Due to several external circumstances several of the originally planned pilot projects did not materialize or not succeed, but PMU successfully adapted the plan and worked with more and smaller business entities and to created easy to replicate showcases.

The **project design is rated satisfactory**, on account of the well-defined and appropriate design, as evident through the clear and detailed project document and Logical Framework. Design suitable for the actual needs of the country in 2016 and still fits -with minor amendments to actual needs.

3.2.Coherence

The WtE project aligned with the Climate Change Focal Area Objectives 2 and 3 of the GEF-5 which are centered on fostering market shifts conducive to investments in renewable energy and low-carbon technologies. It promoted the introduction of selected renewable energy (RE) technologies in South Africa, especially the conversion of Waste to Biogas and the use of digestate as a fertilizer represents an environmentally responsible approach to resource management aimed at mitigating GHG emissions.

The WtE project followed the principles of Agenda 2030/SDGs and had an impact on other SDG goals, such as SDG 4 (Trainings on Renewables), 5 (see chapter 3.7), 7 (Biogas capacity installed) and 8 (improved competitiveness through RE investments).

Furthermore, it concurred with the overarching priorities of the South African government, which are centered on GHG reduction and the exploration of alternative energy sources.

The project design was partially coherent with regional and national policy.

The WtE project responded to and was at least partially aligned with Integrated Resource Plan (IRP) 2010-2030 by DMRE which stated the target of 20,000 MW of capacity from renewable energy sources by 2030.

In terms of renewables, the IRP anticipates an additional capacity of 14,400 MW of wind, 6,000 MW of solar PV and 2,500 MW of hydropower. The IRP has placed build limits on wind and solar PV in order to instil investor confidence by ensuring a constant pipeline of renewable projects.

The IRP promotes a “Just Transition” from coal to alternative sources of energy. The transition represents the trade-off between the need to limit greenhouse gas emissions while mitigating imminent mass job losses to be suffered in the coal industry. The framework identifies key policy areas for a just transition, including: human resource development and skills development in respect of green job opportunities; industrial development, economic diversification, and innovation; and long-term support structures for individuals and communities negatively impacted by the transition. The project was therefore inherently coherent with the national policy.

Informing ongoing and future policy development

Beyond the project’s fundamental alignment with current national and regional policy, the intention was always for WtE to inform ongoing and future policy development (Component 1 – training of government officials and Component 2 Policy briefs). UNIDO collaborated with the DFFE and DMRE along with government institutions and main stakeholder including SABIA, DTIC, ARC and Universities, working on the same themes and achieved many successes through collaborating with its existing channels, networks, and contacts to ensure learning and policy recommendations. While the long-term impact of WtE policy-focused work was yet to be measured, WtE at least was in a strong position to ensure that the policy-relevant outputs could continue to influence ongoing and future policy development. One limitation pertains to the ongoing uncertainty surrounding the regulatory classification of Waste-to-Energy projects within the current legislative framework.

Coherence with other similar interventions

During the PPG the project development team worked with GIZ to ensure that there is no duplication and that synergies are developed from the joint effort. WtE could built up on previous work done by GIZ, such as support given to DoE on formulation a National Biogas Strategy and Action Plan in 2016 and the German Energy Programme (SAGEN) which includes energy efficiency and renewable energy.

Furthermore, WtE focused its support primarily towards small and medium-sized enterprises, with a particular emphasis on sectors with relatively limited prior engagement or development efforts at that stage.

The project is **rated satisfactory on coherence**, reflecting its alignment with South African Government priorities as well as with UNIDO’s and GEF’s focus on SDG 9 and 7 and GHG reduction. But it is still not fully clear where to anchor WtE!

3.3.Effectiveness

This section reviews WtE main results in terms of outcomes and outputs. Details of the outcomes/output indicators, targets and achievements as well as ratings per output are provided in Annex 3 - Progress towards expected results was based on amended Project Logical (or Result) Framework (PLF).

Project Component 1: Capacity building and technology support system:

Output 1.1: Detailed assessment and characterization of waste streams from agro-processing SMMEs conducted and centre for waste characterization established

Characterization of waste-streams and mapping has been completed and 3 detailed reports prepared by UNISA are available. This work was started with ARC, but progress was slow. ARC did not respond on time, and they were not engaged in the project in terms of agreed deliverables. Finally, the assignment was shifted successfully to UNISA.

A Biogas Demonstration Lab – 3 different digesters in a container, including needed lab equipment constructed by Logical Waste - has been finalized and is now ready to be transported to NWU. It was originally planned to buy lab equipment for ARC, but due their shortcoming and shift of work to UNISA, WtE decided to buy a teaching biogas demonstration unit and establish it at NWU premises at Mahikeng, as there is full political buy in at the highest levels. The engagement of NWU and plans for future use was very much visible during TE visit at their premises.

Output 1.2: Biogas support centre created

SABIA has been “given a voice in South Africa” through the support by WtE. Knowledge material is now available and strengthens their capacity. SABIA Webpage is up to date. A Business Plan has been prepared and jointly agreed with board members of SABIA. SABIA is currently developing training materials and programs, and is working on a database of reliable consultants and technology suppliers.

SABIA will set up a Centre of Excellence (CoE) together with ARC on Irene Farm where the ARC Animal Production Institute located. The Head of Institute at ARC confirmed the high priority to collaborate to create this centre. The SABIA webpage is and will likely be in future especially helpful for smaller units that do not have the resources to focus on research work, market recherche and benchmarking.

Output 1.3: Biogas guidelines and decision support tools, operation and manuals for integrated biogas systems in agro-processing SMMEs are developed and disseminated

The initiation of the manual was commenced in collaboration with Fachverband Biogas; however, its subsequent oversight was transitioned to another entity. While the primary content of the manual was drawn from Fachverband, the initial draft of the manual did not align with the specific requirements of the local context. This led to an extensive manual refinement process facilitated by PMU in conjunction with relevant stakeholders (mainly DFFE) resulting in an excellent manual.

The manual was produced (hardcopies) highlighting the project results and impact and shared with stakeholder and industries and is available on SABIA webpage. The principal stakeholders, namely DFFE and DMRE, emphasized the significance of the knowledge materials and verified their active integration within their respective departments. Furthermore, DMRE has leveraged the acquired knowledge to inform the development of a subsequent initiative focused on enhancing wastewater treatment plants.

Biogas Decision-Making Tool has been completed and calibrated and is now ready for uploading onto SABIA website, forming a valuable tool for future projects and respective developers. The tool was successfully showcased at AFRICA Energy Indaba conference in March 2023.

The project also aimed to rejuvenate and provide assistance to projects encountering challenges. The “Success conditions for private sector biogas projects” (see output 3.4) analysed the underlying reasons for project failures (i.e., errors in technological design). As many Biogas projects suffered from incorrect planning and/or poor technical support this document will be highly beneficial in preventing such problems in the future.

Output 1.4: Professionals and technicians in biogas technology trained

The utilization of biogas for schools and household purposes significantly contributes to enhancing health outcomes and fostering skill development, Students highlighted the usefulness of the training (especially the practical part). For those households and schools

who are actively utilizing their digesters, it was a real game changer. Coordinates of all 33 will be part of final UNIVEN report.

Unfortunately, not all the installed biogas digesters are functioning due to manifold reasons. This shows again the vulnerability of biogas to different factors (mainly feedstock and poor/incorrect handling/maintenance) and highlighted the need for a detailed planning phase.

UNIVEN and NWU will focus on WtE training as part of sustainable agriculture in future and plan to develop the necessary curricula.

Though the official accreditation is still pending, the positive output from training for professionals was very much visible. National Cleaner Production Centre (NCPC) did trainings on their own, utilizing project outcomes and experts from the WtE. Training for government officials has been conducted as planned and stakeholders from government entities confirmed the usefulness of those training. Training manuals for government officials are prepared, tested and available.

Output 1.5: Targeted training workshops (10) for market players (project developers, enterprise executives, farmers and operators, current users of waste) on integrated biogas systems conducted

The planned 10 training sessions have been conducted successfully. The number of market players trained was 189 (almost achieving the set target of 200) of which, 30%+ were female. Scanned attendance sheets and feedback forms from all sessions are available. Comprehensive training material and training reports have been prepared by EcoMetrix. These activities had to be shifted partially to online classes due to COVID-19 Pandemic restrictions.

Output 1.6: Only one of the two planned regional training workshops was conducted to train experts from SADC counties on biogas technologies in SMMEs. The variation was communicated to and acknowledged by PSC.

Expected Outcome 1: Capacity of market players and enablers strengthened and technology support systems established

During TE mission it was visible and confirmed in the interviews that WtE has initiated a major improvement on knowledge, trained capacity and the framework for WtE. Involved departments and government bodies recognized and appreciated the results of WtE project and highlighted an improved understanding about the opportunities and merits of biogas as low-carbon technology to reduce GHG emission. Industries highlighted the technical support and the improved position of SABIA.

Numerous previous biogas projects were adversely affected by poor project planning and inadequate technical guidance, primarily stemming from a lack of adequately educated and trained professionals, as well as sound technology providers. SABIA is tasked with creating a roster of reputable and knowledgeable suppliers as well as technical consultants specializing in WtE solutions applicable to households and SMMEs.

UNIVEN and NWU are planning to include the gained knowledge into their curricula. At NWU this will be centred on the Biogas demonstration lab and complement their existing expertise in the field of sustainable agriculture.

Component 1 has achieved the expected Outputs and Outcomes with only minor shortcomings.

Project Component 2: **Biogas market development and regulatory framework**

Output 2.1: Quality standards for integrated biogas plants in SMMEs developed, adopted and widely disseminated

The “South Africa National Standard: Domestic and Commercial use of Biogas” and “South Africa National Standard: The handling and storage of Biogas” have been completed, public consultation process is done, approval from South African Bureau of Standards (SABS) is pending.

Training modules of the two standards have been designed and practically tested on ToT courses and were peer reviewed; Extensive training material on the same for different target groups will be released on SABIA webpage once the standards are approved by SABS.

Output 2.2: Guidelines and regulations (environmental, technical and legal) on the valorisation of digestate and effluent developed and adopted

Decision tools on efficient use of digestate and policy briefs on the same have been prepared by Stellenbosch University in July 2022. University of Pretoria worked on “Feasibility Study on using digestate for soil enhancement in the mining sector (post-mining)”.

Both documents built up on the work done on characterisation of waste-streams under Output 1.1. The WtE project catalysed extensive research into digestate utilization and paved the way for the registration of South Africa's inaugural non-chemical fertilizer option under the Department of Agriculture in DALRRD. Rehabilitation of mines is a big issue in SA and WtE has demonstrated that digestate is a viable option for reclaiming mining sites. Consequently, forthcoming initiatives involving the utilization of WtE by-products (such as slurry and dry products) can access funds earmarked for mining site rehabilitation.

All the documents are well done and in place. Stakeholders stressed the usefulness of those inputs from WtE project, but concrete impact and a clear plan for follow ups for future regulations was not visible.

Output 2.3: Biogas license process streamlined; and

Output 2.4: Regulatory framework on access to the grid by small to medium scale biogas projects developed

It was jointly agreed (PSC meeting 4th March 2019) to forego the implementation of the two outputs as the work had been done and results attained under the efforts of SABIA, DMRE and the National Energy Regulator of South Africa (NERSA). The resources earmarked for the outputs were diverted (with the consent of PSC) to other activities.

Expected Outcome 2: Market environment for biogas strengthened and regulatory framework for grid-connected small to medium scale waste-to-energy projects developed

Research work on use of digestate support the market creation and are already strengthening the sector. But 'wheeling power' regulations in South Africa have the potential to significantly enhance grid stability and reduce greenhouse gas emissions, currently do not facilitate the transmission of electricity generated by Biogas plants despite the enabling legislation that has been promulgated. The limiting factor now is logistical and a pushback by the grid operator on the perceived risk that such feed-ins cause grid instability.

WtE has contributed to creating a platform for cooperation between ministries, respective departments, industries, academia and experts/consultants. But it is still not clear which government entity will focus on Waste-to-energy and Biogas projects, as it is seen as cross-cutting thematic. It is confirmed from all major stakeholder during the interviews that low-carbon technologies are “caught between several stools”.

Component 2 has achieved the expected Outputs and Outcomes with minor shortcomings.

Project Component 3: **Technology demonstration**

Output 3.1: Detailed feasibility studies of selected 5 demonstration projects are conducted

All potential projects that asked for support from WtE had to prepare a detailed feasibility study. All studies are well done and available. So, this target of 5 studies was overachieved by far with 13 proposals were submitted with feasibility studies done on different projects. The resources for this output were redirected to Component 4, Output 4.2 & 4.3 dealing with pre-feasibility feasibility studies.

Output 3.2.: Five (5) integrated biogas demonstration projects implemented to achieve at least 3MW installed capacity

Out of 13 identified projects 5 have been contracted and supported with funds and technical inputs.

- Tongaat Hulett (Later transferred to Barloworld Ingrain)
- Cavalier - CHP
- Midlands - CHP
- Limpopo dairies (not yet fully commissioned) – direct biogas to heat
- Likhanyiso (recently cancelled) – Bio-CNG

Cavalier and Midlands Biogas Project have been decommissioned due to a legal dispute between the Cavalier Abattoir owner/off-taker of power and heat from the project developer (iBert) and there was a technology failure at Midlands Biogas Project.

Both plants operated for a period of approximately one year.

Limpopo Dairies Biogas Project started to fill its lagoon type digester just a few days before ET arrived, is currently under commissioning and its capacity has been increased to 1,500kW. By the end of September 2023 the project was already producing the planned capacity of Biogas.

Likhanyiso bio-CNG was cancelled after UNIDO commissioned an assessment of the current status of the plant that revealed that it would not be completed within the Project period, due to delays in completion of final fittings and utilities for the plant mainly transformer for electricity for the biogas upgrading plant.

During TE mission none of the visited plants were operational and producing biogas.

Actual figures on indicators on annual generated energy and tonnes of biogas were therefore not available, but at the moment of the visit it was zero.

Output 3.3.: Demonstration projects monitored, evaluated and showcased.

The evaluation report done by Resilient Circular focused on the two, Cavalier and Midlands. There was also the assessment of Likhanyiso done by Zero Waste. Other pilots were covered in “Best Practice Manual for Developing Industrial Scale Biogas Projects in South Africa” and lessons learned (also from the failures) have been compiled in the “Success conditions for private sector biogas projects” document.

Output 3.4: Best practice manual developed and widely disseminated

An excellent manual showing the critical steps and extracting the learnings from successful and failed projects has been prepared titled, “Best Practice Manual for Developing Industrial Scale Biogas Projects in South Africa”. Under Output 4.4 a report titled, “Success conditions for private sector biogas projects” was developed complementing the manual.

Expected Outcome 3: Technical feasibility and commercial viability of waste-to-energy technologies demonstrated

The selected projects have been given technical and financial support. The share on financial support was low (about 10%) compared to the overall investments, therefore not allowing the project to have sufficient control over partners and external factors. Although none of those projects were operational during the TE visit, the planned installed capacity was almost achieved (4,3 MW_{el} and 1,96 MW_{thermal}) and some plants have been running for some time and one project was ready to start.⁴

The issues faced while supporting those 5 projects and the support given by WtE project to developers, owners and FIs is definitively a significant learning experience and judging from the learnings from the failure the outcome of this component, this outcome can be rated moderately satisfactory even without a plant functioning as planned during TE visit. The documents (Guidebooks, Decision-Making Tool, Success conditions for private sector biogas projects, Best Practice Manual) will support future project.

Component 3 has achieved some expected results, but there are significant shortcomings that are mostly beyond the control of the PMU and PSC.

Project Component 4: **Scaling Up**

Output 4.1: Investment strategy for integrated biogas developed and disseminated

A detailed report on “Integrated Biogas Investment Report June 2023” has been prepared by GreenCape and will help future project. This includes the database (Excel) “Biogas GreenCape Finance Database May 2023”. These documents will be an important part for project sustainability.

Output 4.2: TA provided to realize at least 4 more investment projects (at least 6 MW)

Four proposed projects were assessed by Private Financing Advisory Network (PFAN) and provided with technical assistance by the WtE project to reach bankability.

The following projects have been supported towards bankability, construction and commissioning, with an overall figure of 14,38 MW :

- Bio2Watt Phase 2 (4MW)
- Riverside Piggeries (320kW)
- Cape Dairy (9.6MW)
- Spif Chicken (463kW)

Output 4.3: Portfolio of at least 25 investment projects compiled and disseminated

A total of 21 biogas projects were submitted for assessment by PFAN on bankability and they are presented in the “PFAN - Assessment of Pipeline Projects - Final Report” from Sept 2021 including the respective table. The original target of 25 was not fully met. To remedy this, an initiative was undertaken to carry out pre-feasibility and feasibility studies on Early-

⁴ While report writing (September 2023) Limpopo Dairies plant was already fully functioning.

Stage Biogas Projects identified through the PFAN submissions and by the PMU based on sectors/sub-sectors and industries that produce organic waste suitable as biogas feedstock. At least 18 such projects were identified and pre-feasibility or feasibility studies and/or business plans were formulated. A part of the resources saved from Output 3.1 were used for this purpose. Several of these Early-Stage Projects are featured in the report titled, “Biogas Projects Deal Book - A Compendium of Biogas Demonstration Projects in South Africa” for soliciting for investor interest in these pipeline projects. The intention is to continually update the Deal Book with new projects and update the those already uploaded as they progress. The Deal Book is likely to contribute significantly in accelerating investment into the biogas industry.

Output 4.4: Technical support to design financial support

GreenCape was contracted to work on this output together with **Output 4.1:** “Investment strategy for integrated biogas developed and disseminated” to explore opportunities for financial support mechanisms both in existence and ideal for the development of the biogas industry. The outcome of this work is included in “Integrated Biogas Investment Report - June 2023”, see Output 4.1

Output 4.5: National biogas investment forum organized regularly

The First National Biogas Investment Forum was held in conjunction with the 4th SABIA National Biogas Conference on 14 – 16th August 2019 with support of WtE project attended by more than 150 registered delegates over the 3 days. All details are covered in “Report Investors Forum August 2019_Final” prepared by SABIA. The planned follow up was not possible due to COVID-19 Pandemic restrictions.

The Second Biogas Investment Forum (& Roundtable Event) was held on 12th October 2022 attended by over 80 delegates in Sandton, South Africa. The event marked the start of the handover of the WtE project responsibilities to SABIA through the activation of their new business plan at the Roundtable component of the event that reached out to prospective corporate partners to join the association and support the broader implementation of the biogas agenda.

Expected outcome 4: Investment in waste-to-energy technologies promoted

The detailed reports on “Integrated Biogas Investment Report June 2023” including the database (Excel) “Biogas GreenCape Finance Database May 2023”, the “PFAN - Assessment of Pipeline Projects” describing the identified financial support for biogas. An excellent manual showing the critical steps and extracting the learnings from successful and failed projects has been prepared, “Best Practice Manual for Developing Industrial Scale Biogas Projects in South Africa” and is complemented by “Success conditions for private sector biogas projects”. These will definitively be of high value for all stakeholder and future project developers and financial institutions.

Therefore, the outcomes from activity 4 will be an important part for project sustainability and the understanding of Biogas as an important low-carbon technology.

Component 4 has achieved some of the expected Outputs and Outcomes with shortcomings that are beyond the control of PMU and PSC.

Many major outcomes have been achieved and appreciated by the interviewed stakeholders. The TE could also identify several unintended positive outcomes, like the establishment of Biogas digesters for small households and schools, showcasing not only their usability for cooking and digestate as fertilizer but the positive side effects for people

(mainly women) living in rural areas (contributes to enhancing health, food quality and fostering skills development).

In addition, the project kick-started a platform for interaction between different academia, government departments and industries and enabled a fruitful discussion and cooperation. All stakeholders interviewed emphasized on the usability of the project results at all levels.

The overall Project Objective was to “Promote market-based adoption of integrated biogas technology in small and medium and micro-scale enterprises (SMMEs) in South Africa...” with an indicator / target number of a “...Cumulative reduction of GHG emissions by about 1 million tCO_{2eq} over the period 2015- 2035...”.

Even though none of the 5 demonstration plants (outcome 3.2) was fully functioning during TE visit, WtE could support the installation of 4,3 MW_{el} and 1,96 MW_{thermal}. WtE has already contributed to direct and indirect GHG emission reduction and Biogas plants leading to lifetime savings (i.e. 20 years) of 711,333 tCO_{2eq}.⁵ and will do more in future.

The **project effectiveness is rated moderately satisfactory**; several output targets achieved or exceeded, substantial progress towards most outcomes already visible. But the main indicator on GHG emission reduction could not be achieved as none of the Biogas project under Component 3 was functioning and detailed calculation on GHG reduction was not available.

3.4. Efficiency

Efficiency assesses how economic and other resources and inputs (funds, expertise, time etc.) are converted to results.

The project ran between Feb 2016 and September 2023. WtE was initially planned to run for 4 years. The project was extended twice, last extension was agreed to give sufficient time for terminal evaluation and project closing, so finally it ran over a period of 92 months. The extensions were needed to address several developments that emerged during implementation. From March 2020 onwards Covid related travel restrictions made project implementation difficult and (international) experts and trainers could not continue with their work in the country. Finally, another extension was needed to achieve project results and conduct the terminal evaluation. Ultimately WtE delivered multiple targeted outputs, despite various delays imposed by issues during implementation of Biogas projects and the trial to revive projects that got stuck.

Although the project was extended for 46 months, stakeholders did not raise any serious issues regarding the timing of delivery. Project extension worked in favour of the project, as most of the work needed more time (e.g., characterization of waste streams and research on utilization of digestate).

Project expenditure

At time of the TE mission in August 2023 around 97% of project funds were spent, the remaining budget was planned to be utilized for remaining activities (i.e., closing and handover event), i.e., USD 4,101,644.11. Changes to fund allocations as a result of actual planning and budget revisions were documented properly and appropriate.

⁵ The GEF tracking tool was shared after the TE mission only; a detailed verification of the calculation was not possible. Given figures include the energy and biogas generation from (already existing) projects supported under 4.2

At project start, it became obvious that cash and in-kind contribution from some of the originally identified industries would not materialize due to the lack of funds and the lost interest, because of low saving potential and high risk involved. UNIDO team and involved stakeholders showed adaptive management by changing some project outputs and adjusted the financial planning, accordingly. All changes have been discussed and agreed in PSC meetings. High flexibility and adaptability were needed to handle the massive project extension, the GEF fund money could be stretched to suffice for the whole project duration.

The table underneath shows the finance status from GEF funds and co-financing at end of the project (Status: September 2022). At Mid-term Review⁶ the co-finance is cited with \$29,640,446 already (showing the status of September 2019).

Table 3: Project budget, utilization, and co-financing:

Project component	GEF financing (in USD)		Co-financing (in USD)	
	Approved	Actual	Promised	Actual
1. Capacity building and technology support system	668 137.00	667 590.95	793 692.00	1 173 909.23
2. Biogas market development and regulatory framework	409 126.00	402 969.05	424 130.00	1 021 943.05
3. Technology demonstration	2 066 723.00	1 975 347.35	18 360 971.00	9 239 989.97
4. Scaling up	807 071.00	779 321.80	21 506 095.00	30 189 189.19
5. Monitoring and evaluation	70 000.00	65 968.46	150 000.00	150 810.81
Subtotal	4 021 057.00	3 891 197.61	41 234 888.00	41 775 842.25
Project Management	201 053.00	210 446.50	650 000.00	1 046 354.50
Total (in USD)	4 222 110.00	4 101 644.11	41 884 888.00	42 822 196.74

Co-financing from industries and financial institutions is significant and highlights the evident interest in WtE within South Africa and developing a comprehensive understanding of Biogas and Digestate as important Low-Carbon technology.

Project Coordination and management

The project also demonstrated well-justified, pragmatic adaptiveness to changes in the operating context, as PMU had to make some changes at outcome level (see details under 3 Effectiveness and Annex 3) to meet various stakeholders' demands and to adapt to the actual situation in the country. All changes have been reported and discussed with main stakeholders and jointly agreed during PSC meetings.

UNIDO office in South Africa was assigned to host the PMU and the National Project Manager (hired by UNIDO) came on board mid-2016. The PMU was responsible for project management and implementation with 1 fully (for the whole project period) employed expert - the National Project Manager - and Project assistant (for 5 years and left in August

⁶ Final MTR Report, page 21 - Unido Biogas Project by Gcobane Quvile, Sept 2019

2022). Given the size and complexity of the project and the number of involved stakeholder this was not sufficient.

UNIDO HQ project management gave the needed support, and reporting towards the GEF focal point was done as mandated. PIRs and Project Progress Update Reports were prepared regularly, but not all of them were written with the needed quality and fully reflected the agreed changes. It was a great advantage that the National Project Manager has been with the project since the project start. Most of the lessons from MTR have been utilized to improve project performance, especially those within the influence of PMU.

Communication

Meeting minutes and reports were properly prepared and circulated, and feedback mechanisms with stakeholders were functioning.

There was no specific focus on external communication (beyond main stakeholder and potential beneficiaries) on the project from the start. The project did not establish a name, logo, or dedicated website. Stakeholders referred to it as the "WtE, Biogas Project in South Africa," but other terms are also used.

The SABIA webpage (run by SABIA, with support from UNIDO) and other activities like National Biogas Investment Forums in August 2019 and October 2022, demonstration projects, the research work that finally led to registration of the first organic fertilizer in the country, created visibility that supported the awareness of stakeholders and industries on WtE and low-carbon technologies.

The **Project Efficiency is rated moderately satisfactory** on account of the high number of demonstration project realized in different industries (even with small rural communities and households) and the high number of experts trained and the lessons learned (converted into valuable knowledge products).

3.5.Sustainability

Project design and implementation structure by UNIDO with close cooperation with concerned ministries, SABIA, Universities and industries has supported Biogas application and low-carbon technology and will continue to support the uptake even more after the project completion.

Two entities have secured the functioning of support and awareness beyond the project end:

- SABIA will continue WtE support (trainings) and maintaining the SABIA webpage, containing all developed knowledge material
- ARC will support SABIA to establish the 'Centre of Excellence' and will give space and resources on their premises (Irene Farm)

The project trained more than 59 youth (plus 36 with theoretical training only) and 35 government officials. In addition, training of 189 market players was conducted. This supported several consultancies and established a linkage with Academia. Training and training materials have been rated by participants very positive. And several courses and training materials are in the process of SETA accreditation.

WtE triggered a substantial amount of Research on the use of digestate and the registration as the first non-chemical-based fertilizer is a strong push towards low-carbon technologies. Participating Universities stated that UNIDO support opened up new ideas and also funding opportunities for extended research on the same.

Main risks to sustainability

Projects on WtE need a multi stakeholder approach. The classification of these projects under specific domains (Energy, Environment, Agriculture, Development, SMME) remains still unclear. None of the involved government entities is willing to take up leadership.

Consequently, the grant schemes and subsidies under which they fall remain uncertain, leading to restricted access to financial support.

Financial Risks:

At present, with existing framework (wheeling procedures, electricity and diesel price, cost and lack of legal compliance on waste treatment) Biogas projects contain high risks of failure. Knowledge products developed by WtE – if properly used – mitigate those risks drastically. WtE implementations are primarily perceived as tools for waste management, not as environmental sound resource management.

- The development of a scheme for ‘payment of environmental service’ - proposed by SABIA - has been discussed during project period. It was then put up to GreenCape as part of their TORs for the Investment Strategy in a highly consultative process with Biogas Industry and the Fis. It is implicit in that subsidies are one way to achieve a boost in the Biogas Industry and that PES could be part of raising the revenues for the subsidies.

Socio political risks:

WtE projects also have a very positive social impact. They not only create new jobs and support skills development; they help to retain jobs by making industries more competitive (e.g., abattoirs). In addition, Biogas has a positive impact on health in rural communities, reducing the exposure to wood fire, especially for women whilst cooking:

- Present accounting and calculation of payback period do not include this positive outcome.
- These factors have to be additionally taken into account when evaluating Biogas projects.

Environmental risks:

No environmental risk visible, WtE projects have additional benefits for environment and work forces. The switch to WtE and use of digestate instead of chemical based fertilizer reduces local pollution and dust levels and is therefore improving health and safety conditions in agro based industries and private households.

The project sustainability is rated satisfactory; SABIA (platform for Biogas) has been given a voice. Industries have understood the business case of WtE (use of Biomethane and Digestate) and will continue to implement after the project end utilizing the knowledge products. Research has been triggered and opened funds for universities which showed high interest for further research and to develop WtE curricula.

3.6. Progress to Impact

A strong platform to promote Biogas has been established (SABIA), though SABIA was seen as the main platform for Biogas even before joint activities started, the project supported them manifold (business plan, knowledge products, joint events,...). As mentioned by the Secretary General of SABIA and confirmed by most stakeholders “...SABIA has been given a voice...” in South Africa. Actually, the Centre of Excellence at the ARC Irene Farm in Centurion (in the Tshwane Metro) is in the making and supported by all key stakeholder.

The project triggered important research on the use of digestate for agriculture and Mine-rehabilitation with very encouraging results. The registration of the first non-chemical-based fertilizer is a strong push towards low-carbon technologies. Not only researchers highlighted this result, it helps existing and future project to increase viability. Universities highlighted that cooperation with UNIDO opened up new funding opportunities for future research work on this important topic.

Awareness of industries on Biogas, Waste management and use of Digestate has started, but needs to be further promoted. A broader uptake is still by limited by missing frameworks and clear regulations.

WtE projects are now seen as challenging but reliable opportunities to reduce Energy and Waste Management costs:

“Lighthouse projects” and knowledge products are driving the change
Regulations for the use of digestate will further support this

Two Biogas standards submitted for approval and the registration process for smaller Biogas Units is streamlined, no distribution license needed. But ‘wheeling agreements’ are still not suitable for small-scale Biogas projects.

Even though none of the 5 demonstration plants WtE has already contributed to direct and indirect GHG emission reduction and Biogas plants are leading to lifetime savings of tCO_{2eq}, and will do more in future.

The project **Progress to Impact is rated moderately satisfactory**; Biogas is seen as business opportunity and a strong platform has been developed. A ‘market’ slowly starts to build up and knowledge products and links between government, experts, industries, FIs and academia will support this. But there is still high risk of failure for Biogas projects and due to circumstance beyond the projects control the contribution on GHG reductions is below the targeted numbers

3.7. Gender Mainstreaming

The United Nations is tasked with advancing social justice by promoting gender equality. Gender mainstreaming entails implementing temporary gender-specific measures to counteract the direct and indirect repercussions of historical discrimination that have left either women or men in a markedly disadvantaged position. Within the framework of its Policy on Gender Equality and the Empowerment of Women, UNIDO's mission to foster inclusive and sustainable industrial development (ISID) hinges on the advancement of gender equality and the empowerment of women. UNIDO actively tackles gender disparities in the industrial sector and harnesses the complete potential of women as influential economic actors and leaders, thus catalysing economic transformations and facilitating inclusive growth.

The revised UNIDO Policy on gender equality was issued in March 2015 and the system of “gender marker” was introduced after the project’s start and WtE retroactively rated 2A, meaning that the project would pay significant attention to gender and was expected to contribute gender equality.

The project design has incorporated gender-related factors, including performance metrics and objectives, across its various components. Additionally, a gender mainstreaming strategy was devised for the project and a Gender Assessment Report was prepared by Eugenia Kula-Ameyaw (February 2017). Nevertheless, it's important to note that this strategy lacks detailed prescriptions for specific actions to be undertaken within the project's individual elements to effectively integrate gender considerations. Instead, it offers a broad conceptual framework.

Through a comprehensive evaluation of documentation and insights from informants, the subsequent domains were recognized for their deliberate inclusion of gender mainstreaming principles:

- The Lukhanyiso initiative in Odendaal, Free State, purposefully included women in the project company's Board of Directors. These women also held positions on the Cooperative Board, and the Community Cooperative possesses a stake in the project company.
- Efforts were undertaken to incorporate both females and youth into the training program, with a particular focus on the selected villages (In the Vhembe district) for the installation of small-scale biodigesters. The target of at least 30% female participation in trainings was achieved
- In addition, WtE supported women at household level to improve their livelihood utilizing Biogas for cooking and digestate for their own food production. This activity was not planned in the design phase, so no target indicator was given. It was a very positive 'by-product' of the Biogas training conducted by the University of Venda.
- Project team spent effort on inclusion of gender aspects in the TORs and adjudication of tender bids to ensure inclusion of women and youths throughout the period of the project.

Although the **Gender mainstreaming is rated moderately satisfactory** a greater focus should have been placed on integrating gender mainstreaming into the various components of the project.

3.8. Environmental Impacts

WtE's objective to revolutionize the renewable energy market by harnessing organic waste from agriculture and agro-processing industries to generate energy in Small, Medium, and Micro-sized Enterprises (SMMEs) was realized. Furthermore, it aimed to promote the utilization of digestate, a byproduct, as a low-carbon fertilizer. This ambitious goal has been realized through a multifaceted approach, including market demonstrations, enhancement of data and knowledge resources, capacity building, provision of technology support, and the fortification of policy and regulatory frameworks. By creating an enabling market environment that encourages the adoption and replication of these innovative technologies WtE is poised to deliver substantial reductions in greenhouse gas emissions and actively contribute to South Africa's transition toward a low-carbon economy.

There was a clear commitment among stakeholders comprising the Project Steering Committee (PSC) to execute a spectrum of measures encompassing legal, organizational, and environmental management initiatives. This comprehensive approach encompassed substantial technological modifications aimed at creating sustainable energy solutions, thereby enhancing the productivity and climate resilience of industries. As a result, this initiative facilitated the creation of green jobs, exemplified by the training and certification of digester installers, while simultaneously stimulating green industrial growth.

Furthermore, it is important to highlight that WtE demonstrated a correlation with specific Sustainable Development Goals (SDGs), namely: SDG 7, which emphasises the critical objective of securing access to economically viable, dependable, sustainable, and affordable energy solutions. (biogas technologies effectively mitigate the reliance on fossil fuels), and SDG 9: which focuses on building resilient infrastructure, promoting inclusive and sustainable industrialization and foster innovation.

Environmental Impact is rated satisfactory; Due to the implementation of WtE, industries (and households) were and will be able to produce energy from organic waste and collaborate with farmers towards the realization of a circular economy.

3.9. Human Rights

WtE reduced the dependence on fossil fuels and fire-wood for cooking mitigating the adverse effects of climate change that disproportionately affect vulnerable rural communities. WtE exemplified the synergy between environmental sustainability and human rights, demonstrating how thoughtful environmental projects (on household level) can advance social equity and well-being.

WtE also efficiently managed the disposing of organic waste, whereby mitigating the adverse health impacts that often afflict marginalized communities living near landfills or in areas with poor waste management systems. Simultaneously, they create employment opportunities and stimulate local economies, thereby improving the socioeconomic conditions of communities.

Human Rights is rated satisfactory; WtE did not only address pressing environmental concerns but also contributed significantly to the enhancement of human rights.

3.10. Performance of Partners

The PMU was exclusively staffed by UNIDO and operated according to the intended structure. This included the appointment of a NPM, as well as a project assistant (who was appointed on a short-term contract). HR support for PMU from other stakeholder - as mentioned in endorsement document - did not materialize.

The PMU was tasked with the responsibility of generating regular reports for primary collaborators, utilizing varying formats. Though improving the quality of project work, this imposed an augmented workload upon the NPM. Given the magnitude and complexity of this project in terms of stakeholders and execution, it was imperative to allocate an increased administrative workforce.

As already stated in MTR report “There are also a large number of outputs that are interdependent, which renders the project coordination-intensive” and “...the roles of various lead partners were not clearly delineated resulting in some partners retreating from fully engaging in the Project, e.g., DMRE as a co-Chair of the Project is not as active as it should be. Similarly, DAFF tended to leave the PSC responsibility to ARC (Equally DSI to CSIR)...”.

UNIDO:

Well-regarded by National Counterparts and stakeholder, providing valued technical inputs and financial support. UNIDO reputation supported initiatives in industries, access to finance and research work conducted by universities.

Several stakeholders raised issue with contracting and timely follow ups on deliverables. PSC members mentioned that contracts are vague and this effects scope of work and deliverables. Several consultants provide poor Reports that did not meet the needed quality standards and delayed submission of final report. Some of the contractors also mentioned that unclear TORs created a lot of extra work and delayed finalization of the work.

National Counterparts:

Government stakeholders played a role in the project decision-making and supported project implementation. PSC chaired by DFFE (department) took a very active role and provided valuable input for the knowledge products and the projects supported by WtE. Government counterparts did not contribute human resources assistance to the endeavour – as originally planned in endorsement document.

GEF:

Limited inputs from GEF, but highly visible support during project initial stages and funds provided on schedule.

The **Performance of Partners is rated satisfactory**

3.11. Results-based Management

Regular and highly participative project steering committee (PSC) meetings were consistently convened, with sustained attendance by key members throughout the project's duration. These meetings recorded through comprehensive minutes and accompanied by detailed progress reports presented in the form of PowerPoint presentations (PPTs).

Detailed action plans including corrective actions as result from progress reports - have been agreed during those meetings.

During PSC meetings the Project logframe was jointly amended to reflect on the ground realities and this demonstrated flexible management attitudes.

The **RBM is rated satisfactory**; Project Progress update and Action Plans were used for planning and corrective actions.

3.12. Monitoring & Reporting

PIRs and Project Progress Update Reports were prepared regularly, but not all of them were written with the needed quality and fully reflected the agreed changes. It was a great advantage that the Project Manager from HQ and National Project Manager (NPM) have been with the project since the project start.

All the needed information was with NPM, but not always 'formalized', no specific project management tool was utilized. A sudden change of responsible personnel might have caused a high risk to data or information loss.

During TE mission – it took place in August 2023 - PMU could not share feasible calculations for CO₂/GHG reductions or saving calculations for Methane mitigation, replacement of chemical fertilizer and GEF tracking was not regularly updated as the responsibility and needed technical knowledge for this calculation was not defined (PMU or HQ). An updated report on finance and co-finance was not available, as some of the final reports were still pending. Both documents have been delivered one month after the mission (26th of September) and could not be verified in detail by ET.

Mid Term Review conducted in March 2019 by Mr Gcobane Quvile. Most recommendations from MTR have been followed by PMU and PSC within their influence.

The **M&E is rated moderately satisfactory**; up to date finance information and the use of GEF tracking tool is obligatory for each GEF funded project. A proper project management tool would have reduced administrative time and effort.

4. Conclusions and Recommendations

4.1. Conclusions

Stakeholders should leverage on the results of UNIDO/GEF Biogas project to support future Biogas projects on South Africa and enhance their impact towards GHG emission reduction at all levels. A clear assignment to one government department and a strong commitment from this department to support biogas initiatives as a low-carbon technology would further support future project.

The WtE project – by learning from success stories and (more important) failures - has developed multiple valuable documents that will support future biogas projects and therefore successfully supported the “...market-based adoption of integrated biogas technology in small and medium and micro-scale enterprises in South Africa...”.

It has not only proven the high value of digestate (to be used from local households, farmers up to mine rehabilitation), but also changed the view point on biogas projects as such. From conversion of waste into energy (either electricity or heat), it is now seen as a tool for environmentally sound resource management and an important part of a ‘circular industrial economy’.

All respective stakeholders should support SABIA to retain the momentum including use of knowledge products, trained and committed experts.

4.2. Recommendations and Management Response

Recommendation 1:

Rehabilitation of exhausted mines is a serious problem in South Africa. Although a huge fund for rehabilitation has been established, not many success stories are visible. WtE project has proven the viability of digestate for rehabilitation of mining projects.

- Therefore, future projects on use of WtE by-products (slurry and/or dry products) should tap into mining rehabilitation funds.

Recommendation 2:

Local project management team and team from UNIDO HQ are not fully aware of the importance of filling the GEF tracking tool to prove the GHG emission reduction figures. It needs a specific expertise to prepare sound calculations. This is especially true for WtE projects.

- UNIDO – to clarify the importance of the GEF tracking tool and respective responsibilities and to develop a standardized method on calculations for GHG emission reduction and to support local project teams to fill the GEF tracking tool correctly

Recommendation 3:

Many activities on WtE in South Africa suffered from poor consultancy service, incorrect assumptions (e.g., on waste stream and Biogas yield) and inadequate equipment and technologies. WtE project supported capacity building at all levels. For interested industries it is still difficult to find appropriate expertise

- SABIA to compile a database of knowledgeable and trust-worthy suppliers and technical consultants for WtE (for household and use in SMME biogas projects).⁷

Recommendation 4:

WtE implementations are primarily perceived as tools for waste management, not as environmental sound resource management or important part of a Circular Economy. They also have a strong social impact and are not only creating new jobs and support skills development; they also help to retain jobs by making industries more competitive (e.g., abattoirs, dairies). Present accounting and calculation of payback period do not include this positive outcome.

- SABIA and Research Institutions/Universities with help of government entities to work on models that factor in health improvement, skills development and support of local communities and food security aspect to convert these factors into 'monetary terms'⁸ to support Financial Institutions and potential investors, and to support formulation of 'sustainable' policies.

Recommendation 5

The consideration of introducing the "payment for environmental services (PES)" concept, contingent on fees associated with responsible waste management or disposal expenses, was deliberated but did not attain consensus.

- Government entities, in collaboration with research institutions, should consider adopting the concept of "payment for environmental services (PES)" and ground it in the findings from the aforementioned research endeavors. This approach may encompass assessments of its social implications, such as health benefits and employment opportunities.

Table 3: Management response

#	Recommendation	Management Actions	Responsible Person	Target Date
1.	Future projects on use of WtE by-products (slurry and/or dry products) should tap into mining rehabilitation funds	Several initiatives are already underway based on studies done during the Project, e.g., use of digestate from a biogas plant supported by Project in mines in the vicinity of the proposed Circular Economy Hub in the designated Lejweleputswa District, Free State Province.	Municipal Manager Lejweleputswa District Municipality	30/12/2023

⁷ During presentation of preliminary findings in SA, it was discussed, that SABIA is already working on a specific database.

⁸ As UNIDO is actually running similar projects in other countries, it would be an option to check whether this idea can be included there (e.g. GEF 5087 in India)

2.	UNIDO – to clarify the importance of the GEF tracking tool and respective responsibilities and to develop a standardized method on calculations for GHG emission reduction and to support local project teams to fill the GEF tracking tool correctly	While the importance of the GEF Tracking Tool has been emphasized all along by the Project Manager, there is a need to have in-house capability at UNIDO HQ level to calculate GHG emission reduction in a standardized approach. Future projects would then have to submit their data to the unit that would perform the calculations.	External Relations Officer	31/01/2024
3.	SABIA to compile a database of knowledgeable and trustworthy suppliers and technical consultants for WtE (for household and use in SMME biogas projects)	The Project supported upgrading of SABIA website to accommodate interactive and secure transactions that allow confidentiality on sensitive issues access to the list of pre-approved, knowledgeable, and trustworthy suppliers. SABIA will have to manage the objective updating of the list hence the need for it to be implemented on a cost recovery basis.	Secretary General SABIA	30/12/2023
4.	SABIA and Research Institutions/Universities with help of government entities to work on models that factor in health improvement, skills development and support of local communities and food security aspect to convert these factors into 'monetary terms' to support Financial Institutions and potential investors, and to support formulation of 'sustainable' policies	The establishment a Biogas Centre of Excellence (CoE) will draw in various aspects and actors to work collaboratively within the CoE framework to produce tangible and usable outcomes that will be accessible by financial institutions and potential investors.	Secretary General SABIA and Head of Station ARC-Animal Production	30/12/2023
5.	Government entities, in collaboration with research institutions, should consider adopting the concept of "payment for environmental services (PES)" and ground it in the findings from the aforementioned research endeavors. This approach may encompass assessments of its social implications, such as health benefits and employment opportunities	SABIA should adopt the policy of PES internally, incorporate it into the Biogas Investment Strategy, and then use the strategy to lobby Government. Once Government concurs, PES can then be mainstreamed into government policy and programmes under a designated authority that will be empowered to levy the industry and waste sector.	Secretary General SABIA and Policy Advisor for Sustainability Programmes and Projects, DFFE	30/09/2024

5. Lessons Learned

The following lessons can be deduced from actual project status documents and discussions and interviews for project stakeholders:

- WtE projects/initiatives are primarily perceived as tools for waste management, with only a limited number of stakeholders recognizing them as a viable approach to environmentally sustainable resource management and a pivotal force for driving the circular economy concept.
- Commencing the implementation of a biogas project necessitates a comprehensive delineation of its intended purpose. Waste-to-Energy projects are usually cross-cutting within the spheres of waste (or more precisely: resource) management and agriculture.

Illustration of industrial project purposes:

- Riverside Piggery: Efficient manure management to lower costs, with biogas production as a favorable byproduct.
 - SPIF Poultry: Achieving energy self-sufficiency via a blend of biogas generation and photovoltaic panels for internal consumption.
 - Limpopo Dairies Biogas Project: Commencing with cost management, evolving towards enhancing food quality, and ultimately transitioning to a 'circular economy' approach.
 - Bio2Watt: Shifting from trading 'green electricity' to enhancing agriculture through responsible resource management, converting waste into bio-fertilizers for a comprehensive 'circular economy' integration.
 - Bio2Watt is providing the BMW plant with environmentally friendly electricity at a premium cost, which BMW is willingly paying as a part of their efforts to decrease greenhouse gas emissions.
 - Limpopo Dairies currently supplies its products to well-established retailers. Going forward, this partnership could potentially be leveraged as a component of retailers' efforts to align with Sustainable Development Goals (SDGs) or corporate sustainability strategies.
- WtE projects have a strong positive impact on society. They create job opportunities and facilitate skills development and ensure that industries become more competitive, which keeps existing jobs intact (like in abattoirs). However, these benefits are often not considered in the current calculations of project returns.
 - Present accounting and calculation of payback period do not include this positive outcome.
 - These factors have to be additionally taken into account when evaluating Biogas projects.

- Biogas applications for households have a very positive impact on health (reduced exposure to emission from cooking on open wood fire).
- Local project management team, national stakeholders and beneficiaries were keen to learn from other country experiences and from UNIDO's success stories in other projects.
 - UNIDO – Project Manager in HQ should include some activities in future for projects to share and promote Best Practice and Success Stories on RE, especially Waste-to-Energy and Biogas applications from UNIDO projects in different countries.
- In a typically designed GEF-5 project there is not sufficient resources for project management allocated, it is not realistic, that involved government departments support with human resources.
- PMUs are normally not equipped (technical knowledge, resources) to calculate GHG emission reductions in detail (especially true for biogas, with multiple reduction sources). A centralized support from headquarter would be supportive and a 'standardized approach' including quality control would ensure that different projects outcome become comparable.

Annexes

Annex 1: Evaluation Terms of Reference



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

TERMS OF REFERENCE FOR PERSONNEL UNDER INDIVIDUAL SERVICE AGREEMENT (ISA)

Title:	Senior evaluation consultant, team leader
ISA Level:	Senior Specialist
Main Duty Station and Location:	Homebased
Mission/s to:	To be approved separately
Start of Contract (EOD):	1 July 2023
End of Contract (COB):	30 September 2023
Contract Type (<i>Regular or WAE</i>):	WAE-30 Days

ORGANIZATIONAL CONTEXT

The United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. The mission of UNIDO, as described in the [Lima Declaration](#) adopted at the fifteenth session of the UNIDO General Conference in 2013 as well as the [Abu Dhabi Declaration](#) adopted at the eighteenth session of UNIDO General Conference in 2019, is to promote and accelerate inclusive and sustainable industrial development (ISID) in Member States. The relevance of ISID as an integrated approach to all three pillars of sustainable development is recognized by the 2030 Agenda for Sustainable Development and the related Sustainable Development Goals (SDGs), which will frame United Nations and country efforts towards sustainable development. UNIDO's mandate is fully recognized in SDG-9, which calls to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". The relevance of ISID, however, applies in greater or lesser extent to all SDGs. Accordingly, the Organization's programmatic focus is structured in four strategic priorities: Creating shared prosperity; Advancing economic competitiveness; Safeguarding the environment; and Strengthening knowledge and institutions.

Each of these programmatic fields of activity contains a number of individual programmes, which are implemented in a holistic manner to achieve effective outcomes and impacts through UNIDO's four enabling functions: (i) technical cooperation; (ii) analytical and research functions and policy advisory services; (iii) normative functions and standards and quality-related activities; and (iv) convening and partnerships for knowledge transfer, networking and industrial cooperation. Such core functions are carried out in Departments/Offices in its Headquarters, Regional Offices and Hubs and Country Offices.

The UNIDO Independent Evaluation Unit (EIO/IEU) is responsible for the independent evaluation function of UNIDO. It supports learning, continuous improvement and accountability, and provides evidence-based analysis and assessment on result and practices that feed into the programmatic and strategic decision-making processes. Independent evaluations provide credible, reliable and useful assessment that enables the timely incorporation of findings, recommendations and lessons learned into the decision-making processes at organization-wide, programme and project level. EIO/IEU is guided by the UNIDO Evaluation Policy, which is aligned to the norms and standards for evaluation in the UN system.

PROJECT CONTEXT

UNIDO is working in collaboration with South Africa's National Department of Environmental Affairs (DEA), Department of Energy (DOE), Department of Trade and Industry (DTI) and the South African Biogas Industry Association are implementing the Global Environment Funded (GEF) project entitled, "**Promoting organic waste-to-energy and other low-carbon technologies in micro, small and medium scale enterprises (SMMEs): Accelerating biogas market development in South Africa**". The project seeks to promote market-based adoption of integrated biogas technologies in small, medium and micro-scale enterprises in South Africa in line with the country drive to promote the development of the renewable energy sector as well as shift towards a green economy. The project has four (4) components namely: capacity building and technology support system; market development and regulatory framework; technology demonstration; and scaling up.

Under the GEF's Climate Change Mitigation Focal Areas 1 and 3 (https://www.thegef.org/gef/sites/thegef.org/files/webpage_attached/GEF6_programming_directions_final_0.pdf), the project will demonstrate the technical feasibility and commercial viability of integrated biogas technologies in selected SMMEs and deploy at least 3MW integrated biogas system on the ground, and support investment in additional 6MW of integrated biogas systems. The Project counts on a GEF grant of US\$ 4.22 million and will mobilise an additional US\$ 41.88 million from private sector and the Government of South Africa.

FUNCTIONAL RESPONSIBILITIES

The senior evaluation consultant will evaluate the project in accordance with the evaluation-related terms of reference (TOR). S/he will perform, inter alia, the following main tasks:

MAIN DUTIES	Concrete/ measurable Outputs to be achieved	Expected duration	Location
<p>1. Review project documentation and relevant country background information (national policies and strategies, UN strategies and general economic data). Define technical issues and questions to be addressed by the national technical evaluator prior to the field visit. Determine key data to collect in the field and adjust the key data collection instrument if needed. In coordination with the project manager, the project management team and the national technical evaluator, determine the suitable sites to be visited and stakeholders to be interviewed.</p>	<ul style="list-style-type: none"> Adjusted table of evaluation questions, depending on country specific context; Draft list of stakeholders to interview during the field missions. Identify issues and questions to be addressed by the local technical expert 	4 days	Home-based
<p>2. Prepare an inception report which streamlines the specific questions to address the key issues in the TOR, specific methods that will be used and data to collect in the field visits, confirm the evaluation methodology, draft theory of</p>	<ul style="list-style-type: none"> Draft theory of change and Evaluation framework to submit to the Evaluation Manager for clearance. 	2 days	Home-based

change, and tentative agenda for field work. Provide guidance to the national evaluator to prepare initial draft of output analysis and review technical inputs prepared by national evaluator, prior to field mission.	<ul style="list-style-type: none"> • Guidance to the national evaluator to prepare output analysis and technical reports 		
3. Briefing with the UNIDO Independent Evaluation Unit, project managers and other key stakeholders at UNIDO HQ (included is preparation of presentation).	<ul style="list-style-type: none"> • Detailed evaluation schedule with tentative mission agenda (incl. list of stakeholders to interview and site visits); mission planning; • Unit of evaluation tasks with the National Consultant. 	1 day	Through a remote platform
4. Conduct field mission to South Africa	<ul style="list-style-type: none"> • Conduct meetings with relevant project stakeholders, beneficiaries, the GEF Operational Focal Point (OFP), etc. for the collection of data and clarifications; • Agreement with the National Consultant on the structure and content of the evaluation report and the distribution of writing tasks; • Evaluation presentation of the evaluation's preliminary findings, conclusions and recommendations to stakeholders in the country, including the GEF OFP, at the end of the mission. 	12 days (incl. travel days)	Various sites in South Africa
5. Present overall findings and recommendations to the stakeholders at UNIDO HQ	<ul style="list-style-type: none"> • After field mission(s): Presentation slides, feedback from stakeholders obtained and discussed. 	1 days	Through a remote platform
6. Prepare the evaluation report, with inputs from the National Consultant, according to the TOR; Coordinate the inputs from the National Consultant and combine with her/his own inputs into the draft evaluation report. Share the evaluation report with UNIDO HQ and national stakeholders for feedback and comments.	<ul style="list-style-type: none"> • Draft evaluation report. 	8 days	Home-based

7. Revise the draft project evaluation report based on comments from UNIDO Independent Evaluation Unit and stakeholders and edit the language and form of the final version according to UNIDO standards.	• Final evaluation report.	2 days	Home-based
	TOTAL	30 days	

MINIMUM ORGANIZATIONAL REQUIREMENTS

Education: Advanced university degree in environment, energy, engineering, economics, development studies or closely relevant discipline is **required**.

Experience, technical and functional expertise

- A minimum of 10 years of progressively responsible working experience in implementation and/or evaluation of development projects and programmes, including experience at the international level, is **required**.
- Knowledge about GEF operational programs and strategies and about relevant GEF policies such as those on project life cycle, M&E, incremental costs, and fiduciary standards is **required**.
- Experience relevant to technical cooperation in developing countries, is **required**.
- Experience in evaluating the needs, conditions and problems in developing countries is **required**.
- Experience in the evaluation of GEF projects and knowledge of UNIDO activities is **desirable**.
- Familiarity with gender analysis tools and methodologies is **desirable**.

Languages: Fluency in written and spoken English is **required**. All reports and related documents must be in English and presented in electronic format.

Absence of conflict of interest:

According to UNIDO rules, the consultant must not have been involved in the design and/or implementation, supervision and coordination of and/or have benefited from the programme/project (or theme) under evaluation. The consultant will be requested to sign a declaration that none of the above situations exists and that the consultants will not seek assignments with the manager/s in charge of the project before the completion of her/his contract with the UNIDO Independent Evaluation Unit.

REQUIRED COMPETENCIES

Core Values

WE LIVE AND ACT WITH INTEGRITY: work honestly, openly and impartially.

WE SHOW PROFESSIONALISM: work hard and competently in a committed and responsible manner.

WE RESPECT DIVERSITY: work together effectively, respectfully and inclusively, regardless of our differences in culture and perspective.

Key Competencies

WE FOCUS ON PEOPLE: cooperate to fully reach our potential –and this is true for our colleagues as well as our clients. Emotional intelligence and receptiveness are vital parts of our UNIDO identity.

WE FOCUS ON RESULTS AND RESPONSIBILITIES: focus on planning, organizing and managing our work effectively and efficiently. We are responsible and accountable for achieving our results and meeting our performance standards. This accountability does not end with our colleagues and supervisors, but we also owe it to those we serve and who have trusted us to contribute to a better, safer and healthier world.

WE COMMUNICATE AND EARN TRUST: communicate effectively with one another and build an environment of trust where we can all excel in our work.

WE THINK OUTSIDE THE BOX AND INNOVATE: To stay relevant, we continuously improve, support innovation, share our knowledge and skills, and learn from one another.

Annex 2: Evaluation Framework / Matrix

Key evaluation questions	Guiding sub-questions	Means of Measurement	Data Sources
RELEVANCE			
1. How relevant was the project to UNIDO? To target beneficiaries? To the donor?	<ul style="list-style-type: none"> Was the project a technically adequate solution to the development problem? Did the project respond to the cause of the problem? Did the project respond to UNIDO's comparative advantage? 	<ul style="list-style-type: none"> Documented evidence of priority needs for UNIDO, South Africa, participating countries and industry stakeholders. Analysis of the project's comparative advantage and feedback from stakeholders 	<ul style="list-style-type: none"> Document review Project records on training, # of participants (by gender) and any feedback results Stakeholder & participant Interviews
2. To what extent was the project suited to the priorities and policies of the target group, recipients, and donor?	<ul style="list-style-type: none"> How did the project fulfil target group needs? To what extent was the project aligned with the development priorities of the countries involved. How did the project reflect donor policies and priorities? Are the original project objectives still valid and pertinent for the target group? 		<ul style="list-style-type: none"> Strategic documents Supervision mission & project reports Government representative interviews UNIDO staff and stakeholder interviews Survey analysis Participant interviews & focus groups
EFFICIENCY			
3. How economically were resource inputs converted to results?	<ul style="list-style-type: none"> How economically were resources used to produce results? To what extent were expected results achieved within the original budget? 		
4. Has the project achieved good value for money?	<ul style="list-style-type: none"> What factors impacted the efficiency of achievement of results? Did the project efficiently achieve results compared with alternative approaches? What measures were taken during planning and implementation to ensure efficient use of resources? Was there potential for greater results with the same resource inputs? 		

	<ul style="list-style-type: none"> Were expected inputs from UNIDO and counterparts provided as planned? 		
5. How timely was the delivery of expected results?	<ul style="list-style-type: none"> To what extent were expected results achieved within the original timeframe? What factors impacted the efficiency of achievement of results? Were project activities in line with scheduling in work plans? 	Timeline review	<ul style="list-style-type: none"> UNIDO documents Project documents Project staff interviews Stakeholder interviews KPI Table
EFFECTIVENESS			
6. Has the project done things right?	<ul style="list-style-type: none"> What is the quality of results? How do stakeholders perceive results achieved? Are results achieved attributable to the project? Were intended target groups reached by project results? Is there valid evidence of results achieved? 	<ul style="list-style-type: none"> Performance by component, activity & indicators Stakeholder and participant perceptions on performance Field level assessment of targeting Stakeholder and participant perceptions on targeting 	<ul style="list-style-type: none"> Project documents Progress reports & project database Relevant government policies Laboratory documents Industry documents Stakeholder interviews Survey analysis Participant interviews and FGDs
7. To what extent have the expected results been achieved or are likely to be achieved?	<ul style="list-style-type: none"> For each project component were targets achieved? What are the main results of the project at the output and outcome level? Were different results achieved in different areas? What are the reasons for any variance? 	<ul style="list-style-type: none"> Performance by component, activity & indicators Project staff, stakeholders, and participant feedback on results 	<ul style="list-style-type: none"> Project documents Progress reports & project database Laboratory documents Industry documents Promotional materials Survey analysis Staff and stakeholder interviews
8. What are the project's key results (outputs, outcome and impact)?	<ul style="list-style-type: none"> For each project component were targets achieved? What are the main results of the project at the output and outcome level? Were different results achieved in different areas? What are the reasons for any variance? 	<ul style="list-style-type: none"> Performance by component, activity & indicators Project staff, stakeholders, and participant feedback on results 	<ul style="list-style-type: none"> Project documents Progress reports & project database Laboratory documents Industry documents Promotional materials Survey analysis Staff and stakeholder interviews
9. What are the key drivers and barriers to achieve the long-term objectives?	<ul style="list-style-type: none"> What factors have affected the achievement of expected results? What factors have assisted towards the achievement of expected results? 	Project staff, stakeholders, and participant feedback on results	<ul style="list-style-type: none"> Project documents Progress reports & project database Industry documents Survey analysis Staff and stakeholder interviews
COHERENCE			
10. To what extent was the project aligned with the global development agenda?	<ul style="list-style-type: none"> To what extent was the project aligned with the goals and targets of the 2030 Agenda? To what extent was the project aligned with the principles of the 2030 Agenda? Has the extent of alignment with global 	<ul style="list-style-type: none"> Document review Interviews with project staff 	<ul style="list-style-type: none"> Project design documents Staff and stakeholder interviews

	agendas changed over time?		
11. To what extent does the project avoid duplication with other similar interventions?	<ul style="list-style-type: none"> To what extent did the project design acknowledge the work of other development actors in the sector? To what extent did project implementation address gaps in other interventions? 	Document review/Interviews with project staff	<ul style="list-style-type: none"> Project design documents Staff and stakeholder interviews
PROGRESS TO IMPACT			
12. Are there opportunities for broader impact from project results?	<ul style="list-style-type: none"> To what extent are lessons and results from the project incorporated into broader stakeholder mandates and initiatives? Has institutional change resulted from the project? To what extent are the project's results replicable? <p>To what extent could the project's approach and results be implemented at a larger scale?</p>	<ul style="list-style-type: none"> Strategic review of context Institutional assessment 	<ul style="list-style-type: none"> Document review Relevant government policies Staff and stakeholder interviews Survey analysis
13. What long term effects have been produced by the project?	<ul style="list-style-type: none"> What difference has the project made for beneficiaries? To what extent are changes attributable to project activities? What are the social, economic and environmental effects, either short-, medium- or long-term, on a macro and micro level? 	<ul style="list-style-type: none"> Project outcome indicator performance <p>Strategic analysis of context for contribution to impact</p>	<ul style="list-style-type: none"> Document review Staff and stakeholder interviews Participant interviews and FGDs Survey analysis
14. What effects from the project were intended and unintended, both positive and negative?	<ul style="list-style-type: none"> What environmental safeguard effects resulted from the project? What economic performance effects resulted from the project? What social inclusiveness effects resulted from the project? Were any results transformational? What was the key change and causes? Were project assumptions valid? 	Contribution analysis from Theory of Change	<ul style="list-style-type: none"> Project documents Staff and stakeholder interviews Participant interviews and FGDs Survey analysis
15. To what extent has the project	<ul style="list-style-type: none"> To what extent has the project 	Contribution analysis from Theory of Change	<ul style="list-style-type: none"> Project documents

<p>helped put in place the conditions likely to address the drivers, overcome barriers and contribute to the long-term objectives?</p>	<p>contributed to reduced policy barriers?</p> <ul style="list-style-type: none"> • To what extent has the project contributed to the application of new knowledge? • To what extent has the project contributed to diversified products? • To what extent has the project contributed to the increased availability of new technology and infrastructure? 		<ul style="list-style-type: none"> • Staff and stakeholder interviews • Participant interviews and FGDs • Government stakeholder interviews
SUSTAINABILITY			
<p>16. To what extent are the achieved results likely to sustain after project completion?</p>	<ul style="list-style-type: none"> • Will project results be sustained after the end of donor funding? • Does the project have an exit strategy? How likely is it that this strategy will succeed? • To what extent have results and outputs been institutionalized? • What is the rate of uptake of new instruments and technologies? Will these rates be sustained/ improved? • Have improved systems been incorporated into state budgets? • Is adequate staffing and support being applied to continue processes? • What progress was made towards the conditions needed to address the long-term objectives? 	<ul style="list-style-type: none"> • Institutional assessment • Stakeholder feedback on sustainability initiatives • Project outcome indicator performance • Institutional assessment • Stakeholder feedback and documentation on budget allocations • Contribution analysis from Theory of Change 	<ul style="list-style-type: none"> • Project documents • Stakeholder and participant interviews/FGDs • Survey analysis • Synthesis of data sources
<p>17. How resilient to risk are project benefits?</p>	<ul style="list-style-type: none"> • What is the likelihood of financial and economic resources not being available beyond the end of the project? • Are there any social or political risks that may jeopardize the sustainability of project outcomes? • Is the level of stakeholder ownership sufficient 	<ul style="list-style-type: none"> • Risk analysis • Contribution analysis • Stakeholder and participant feedback on ownerships and risks 	<ul style="list-style-type: none"> • Synthesis of data sources • Stakeholder and participant interviews and focus groups.

	<p>to allow for the continuation of project benefits and outcomes?</p> <ul style="list-style-type: none"> • Are stakeholders aware of the potential of continuing project benefits? • Is there sufficient public and stakeholder awareness of project activities and benefits to support the project's long-term project objectives? • Have risk management plans been established, including monitoring actions? 		
PERFORMANCE OF PARTNERS			
18. What was the quality of implementation?	<ul style="list-style-type: none"> • To what extent did project executing entities deliver effectively? • How well did the project executing entities identify and manage risks? 	<ul style="list-style-type: none"> • Feedback from project staff and donor representatives • Document review 	<ul style="list-style-type: none"> • Project documents • Interviews with project staff • Interviews with donor representatives
19. What was the quality of execution?	<ul style="list-style-type: none"> • Were funds used appropriately? • How successful was the procurement and contracting of goods and services? 	<ul style="list-style-type: none"> • Feedback from project staff and donor representatives • Document review 	<ul style="list-style-type: none"> • Project documents • Interviews with project staff • Interviews with donor representatives
LESSONS LEARNED			
20. What lessons can be drawn from the successful and unsuccessful practices in designing, implementing and managing the project?	<ul style="list-style-type: none"> • Has UNIDO and its partners documented and addressed the lessons in potential follow-on activities? • Have lessons learned identified during the mid-term review been actioned? 	<ul style="list-style-type: none"> • Performance by component, activity & indicators • Staff and stakeholder feedback on implementation lessons • Project staff, stakeholder and participant feedback on results 	<ul style="list-style-type: none"> • Document review • Project staff and stakeholder interviews • Survey analysis • Synthesis of data sources

Annex 3: Progress towards expected results (based on the on PLF) and rating table

Expected results	Indicator	Baseline	Terminal Evaluation		Rating	Justification for rating
			Target	Actual		
<p>Project Objective Promote market based adoption of integrated biogas technology in small and medium and micro-scale enterprises (SMMEs) in South Africa.</p>	<p>CO2 emission reduced (tonnes of CO2eq) due to new biogas projects [direct/indirect] Energy generated from biogas technologies supported or promoted by project (in MWh)</p> <p>No of new SMME-based biogas projects</p>	<p>0 Direct CO2eq emission reductions associated with new projects</p> <p>0 Indirect CO2eq emission reductions associated with new projects</p> <p>0 MWh generated from biogas technologies supported or promoted by project</p> <p>No new agro SMME biogas projects</p>	<p>Cumulative reduction of GHG emissions by about 1 million tCO_{2eq} over the period 2015-2035</p> <p>Indirect emission reduction greater than 1.8m tCO_{2eq}</p> <p>55,000 MWh energy generated annually from biogas through projects installed over the period 2015-2035 related to project</p> <p>13 new biogas projects at SMMEs installed between 2015 and 2019</p>	<p>711.333 tCO_{2eq}⁹</p> <p>54.803 MWh annually</p> <p>13 feasibility studies conducted (details see output 3.2. and 4.2)</p>	<p>MS</p>	<p>The PMU team calculated the achieved direct emission reduction figures. Working with the assumption that biomass plants have an average lifetime of 20 years, this result in lifetime savings of 711.333 tCO_{2eq}.</p> <p>The indirect reductions have not been calculated in detail, but with the main project impacts (proven WtE technologies in various show cases, WtE for rural Communities and household, Digestate registered as non-chemical fertilizer and to be utilized for mine rehabilitation, 2 SA standards implemented) and also the fact that the project has trained/sensitized 400+ people on use of Biogas and Digestate it seems realistic that the figure on CO₂ reductions can be achieved.</p> <p>ET wants to highlight GHG emission reduction from WtE comes additionally from multiple sources, such as Methan mitigation, replacement of oil based imported fertilizer and reduced emission from transport (local use) that are not included in the above calculations. Use of Biogas in rural communities has also multiple other benefits (skills development, reduced exposure to smoke while cooking,</p>

⁹ This figures includes the generation from projects supported under 4.2

						higher food quality), that are not included in above calculations
Project Component 1 – Capacity building and technology support system						
Outcome 1 Capacity of market players and enablers strengthened and technology support systems established	No. of trained personnel (gender disaggregated) Waste characterization database developed and available Biogas guidelines developed and available Full time staff at SABIA able to support members	Few trained personnel No national waste characterization database No S.A biogas guideline No fulltime staff and SABIA not able to support members	300 personnel trained (30% female personnel) Waste characterization database developed and available S.A biogas guidelines developed and available 1.5 full time staff at SABIA able to support biogas market (e.g. advice and Information		S	All training reports are available and include participant's lists. But an overview document of all trainings and an up-to date database of trainees were not available. Therefore, the planned survey could not be conducted. All the training material is available but SETA accreditation pending SABIA has become the voice for Biogas on South Africa
Output 1.1 Detailed assessment and characterization of waste streams from agro-processing SMMEs conducted and centre for waste characterization established	No. of waste streams Characterized National waste characterization database developed	Limited South African waste streams characterised No national waste characterisation database	150 waste streams Characterized Database developed and updated	Characterization of waste-streams and mapping – complete 3 detailed report prepared by UNISA are available Biogas demonstration lab finalized and ready to be transported to NWU	S	This work was started with ARC, but progress was slow. ARC did not respond on time, and they were not engaged in the project in terms of agreed deliverables. Finally, the assignment was shifted successfully to UNISA. 3 reports are now available and form a reliable data base (including geographical mapping) to support calculation on feedstock and yield for future projects in SA It was planned to buy lab equipment for ARC. But due their shortcoming and shift to UNISA, WtE decided to buy a teaching biogas demonstration unit (constructed by Logical Waste) at NWU, as there is full

						<p>political buy in at the highest levels. The engagement of NWU and plans for future use was very much visible during TE visit at their premises.</p> <p>This is also part of the support in strengthening SABIA business plan and came from the budget that was earmarked for the equipment</p>
<p>Output 1.2 Biogas support centre created</p>	<p>No. of full-time staff</p> <p>Up to date website</p>	<p>No full-time members of staff</p> <p>Out of date website</p>	<p>1.5 full time staff members (gender disaggregated)</p> <p>Up to date website</p>	<p>Capacity building services rendered to Biogas Association equivalent to 1.5 full-time staff. Programme Manager recruited and supported by Project up to end of Project as handover process Website active</p>	<p>S</p>	<p>SABIA has been supported by WtE .Knowledge material (see underneath) is now available and the Webpage is up to date. A Business plan has been prepared and jointly agreed with board members of SABIA.</p> <p>SABIA has been “given a voice in South Africa” A centre of excellence together with and on the premises of ARC farmland (IRENE) is in the making</p>
<p>Output 1.3 Biogas guidelines and decision support tools, operation and manuals for integrated biogas systems in agro-processing SMMEs are developed and disseminated</p>	<p>Biogas guidelines Developed</p> <p>No. of downloads of document</p>	<p>No South African biogas guidelines</p> <p>No downloads</p>	<p>1 set of biogas guidelines developed</p> <p>>200 downloads (gender disaggregated user statistics)</p>	<p>Biogas Guidebook - complete and published (300 copies) Biogas Decision-Making Tool - complete and calibrated ready for uploading onto SABIA website Biogas Operators’ Manual - final</p>	<p>HS</p>	<p>The 3 main knowledge products are done and –as confirmed by several stakeholders interviewed during TE mission - regularly used and very helpful.</p> <p>The decision-making tool has been tested and calibrated by Resilient Circular and is fully functioning. It was successfully showcased at AFRICA Energy Indaba conference in march 2023</p> <p>As many Biogas projects suffered from incorrect planning and poor technical support, these documents will be of huge advantage for any future projects</p>

				editing done and complete		
Output 1.4 Professionals and technicians in biogas technology trained	<p>SETA accredited HH biogas training available</p> <p>No. of youth trained in HH biogas</p> <p>% of female youth Trainees</p> <p>No. of household digesters built as part of training</p> <p>No. of SAQA accredited biogas technician courses</p> <p>No. short (1 week) biogas courses developed</p> <p>No. of biogas training sessions for Government Officials</p> <p>No. of trained Government Officials</p>	<p>No SETA accredited HH biogas training</p> <p>9</p> <p>10%</p> <p>0</p> <p>No SAQA accredited biogas course</p> <p>No short biogas Courses</p> <p>1 training on biogas for Government Officials</p> <p>No trained Government Officials</p> <p>No biogas trained female</p>	<p>2 SETA accredited HH biogas training courses available</p> <p>80</p> <p>30%</p> <p>30</p> <p>1 SAQA accredited course available at SARETEC and satellites</p> <p>3 short biogas courses Developed</p> <p>2 training sessions on biogas for Government Officials</p> <p>20 trained staff</p> <p>30%</p>	<p>Training materials prepared and tested; SETA accreditation pending 6 (out of seven) Reports available</p> <p>59, plus 36 (theory only)</p> <p>30%+</p> <p>33</p> <p>Development of a SAQA accredited course initiated through National Biogas Platform approval of the course outline pending 3 short biogas course developed</p> <p>2 training sessions on biogas for Government officials – one in</p>	S	<p>Though the official accreditation is still pending, the positive output from training for professionals was very much visible.</p> <p>Students highlighted the usefulness of the training (especially the practical part). UNIVEN and NWU will focus on WtE trainings as part of sustainable agriculture in future and plan to develop curricula.</p> <p>For those households and small schools who are really utilizing their digesters, it was a real game changer. Coordinates of all 33 will be part of final UNIVEN report. Unfortunately not all of the installed bio digesters are functioning due to manifold reasons.</p> <p>This shows again the vulnerability of biogas to different factors (mainly feedstock and poor/incorrect handling/maintenance)</p> <p>Use of Biogas for cooking in small households has multiple benefits (mainly for women). It saves time for cooking itself, reduces exposure to harmful smoke (cooking is mostly done on open wood fire) and reduces logging for firewood. Last not least helps the digestate with home-grown vegetables and ensures better nutrition for rural communities and school children</p> <p>SAQA (it should be EWSETA) is not the correct entity for this approval, an incorrect indicator from design phase is still in the logframe</p>

	<p>% of female trained Government Officials</p> <p>No. of biogas training sessions for MCEP/NCPC Staff</p> <p>No. of trained MCEP/NCPC staff</p> <p>% of female trained MCEP/NCPC staff</p> <p>No. of digestate use training sessions</p> <p>No. of trained personnel in digestate use</p> <p>% of female trainees in digestate use</p>	<p>Government Officials</p> <p>No training on biogas for MCEP/NCPC staff</p> <p>No trained MCEP/NCPC staff</p> <p>No biogas trained female MCEP/NCPC staff</p> <p>None</p> <p>None</p> <p>None</p>	<p>2 training sessions on biogas for MCEP/NCPC staff</p> <p>20 trained staff</p> <p>30%</p> <p>5</p> <p>100</p> <p>30%</p>	<p>Limpopo Province and one at national level</p> <p>35 government officials trained</p> <p>Over 30% women</p> <p>MCEP and NCPC did the trainings on their own</p> <p>dropped</p> <p>dropped</p> <p>Training materials ready for SETA accreditation submission</p> <p>Not yet achieved</p>	<p>Training manuals for government officials are prepared, tested and available!</p> <p>Though stakeholders from government entities confirmed the usefulness of those trainings, no direct outcome was visible</p> <p>MCEMP and NCPC used the project outcomes and some of the project consultants (i.e. Mark Tiepelt – Resilient Circular) to produce training programmes in their own capacity, this was in collaboration with GIZ</p> <p>It was jointly agreed in PSC meeting to drop this indicator</p>
<p>Output 1.5</p> <p>Targeted training workshops (10) for market players (project developers, enterprise executives, farmers and operators, current users of waste) on integrated biogas systems conducted</p>	<p>No. of training workshops for market players</p> <p>No. of market players trained</p> <p>% of female trainees</p>	<p>None</p> <p>None</p> <p>None</p>	<p>10</p> <p>200</p> <p>30%</p>	<p>10 training sessions done</p> <p>189 market player trained</p> <p>30%+ female</p>	<p>S</p> <p>Comprehensive training material and training reports prepared by EcoMetrix. Scanned attendance sheets and feedback forms from all sessions are available. Overall 1workshops for Output 1.5 -1.6.</p>

<p>Output 1.6 Two Regional training workshops conducted to train experts from SADC counties on biogas technologies in SMMEs</p>	<p>No. of regional biogas workshops</p>	<p>No regional biogas workshops</p>	<p>2 regional training workshops (at least 30% female participants)</p>	<p>One regional training workshop completed</p>		<p>See 1.5.</p>
<p>Project Component 2 – Biogas market development and regulatory framework</p>						
<p>Outcome 2 Market environment for biogas strengthened and regulatory framework for grid-connected small to medium scale waste-to-energy projects developed</p>	<p>No. of quality standards for biogas Guidelines on use of digester effluent and digestate Norms and standards developed for biogas at DEA Regulatory framework developed for < 1MW biogas projects</p>	<p>No S.A standards for biogas projects No guidelines on use No norms and standards for biogas No clear policy or regulation on grid connection < 1MW</p>	<p>Two S.A standards for biogas projects adopted Guidelines issued on use of digester effluent and digestate 1 set of norms and standards for biogas Clear policy on grid connection < 1MW</p>		<p>S</p>	<p>Standards are in place and ready for SABS approval. Important research work on use of digestate has been done and will trigger future work. Digestate is now understood as valuable (By-)Product from Biogas plants and is even recommended for mine rehabilitation A clear policy and regulatory to support smaller biogas units framework have not been developed, as biogas implementations are seen as cross-cutting thematic and is still not clear which government entity will focus on Waste to energy and Biogas projects,</p>
<p>Output 2.1 Quality standards for integrated biogas plants in SMMEs developed, adopted and widely disseminated</p>	<p>No. of quality standards for biogas Integration of the standards within PER R719 SETA certified training materials for the standards</p>	<p>No S.A standards for biogas projects Biogas not integrated in PER R719 No certified training materials</p>	<p>Two S.A standards for biogas projects adopted by SABS Integration of the standards within PER R719 SETA certified training materials for the two standards Training modules for the two standards</p>	<p>Standards complete and submitted to SABS for approval The framework is complete awaiting standards approval Training modules of the</p>	<p>S</p>	<p>“South Africa National Standard Domestic and Commercial use of Biogas” and “South Africa National Standard. The handling and storage of Biogas” have been completed, public consultation process is done. But approval from SA Bureau of Standards is pending Training material prepared and tested.</p>

	Training modules designed	No training modules for standards	designed and practically tested on ToT course and peer reviewed	two standards designed and practically tested on ToT course and peer reviewed Extensive training material available		
Output 2.2 Guidelines and regulations (environmental, technical and legal) on the valorisation of digestate and effluent developed and adopted	<p>Characterisation of effluent and digestate from different biogas feedstocks</p> <p>Testing of effluent use on crops and record results</p> <p>Guidelines on use of digester effluent and digestate</p>	<p>No characterization of effluent and digestate</p> <p>No data available of testing effluent on crops</p> <p>No guidelines on use</p>	<p>Guidelines issued on use of digester effluent and digestate</p> <p>Characterisation of digestate from 7 shortlisted biogas feedstocks Selection of 5 best performing digestate types for further tests for efficacy</p> <p>Testing of 5 (best performing) out of the 7 shortlisted digestate types carried out over two agricultural seasons and data recorded</p>	<p>Policy briefs on disposal of digestate completed Study of potential market of digestate done Decision-making tool for digestate use completed Composition of digestate lab tests completed</p> <p>Efficacy of digestate from selected feedstocks – 90% complete</p> <p>Ongoing and dependent on seasons – 50% to completion</p>	S	<p>Decision tools and policy briefs on the same have been prepared by Stellenbosch University in July 2022.</p> <p>University of Pretoria worked on “Feasibility Study on using digestate for soil enhancement in the mining sector (post-mining). Rehabilitation of mines is a big issue in SA. The outcome was very promising and is therefore giving the option to tap into the mining rehabilitation funds Both documents built up on the work done for output 1.1.</p> <p>All the documents are well done and in place. Stakeholders stressed the usefulness of those inputs from WtE project, but concrete impact and are clear plan for follow ups was not visible.</p> <p>As mentioned several times, it is still not clear which government entity will focus on Waste to energy and Biogas projects, as it is seen as cross-cutting thematic. At the moment it seems these low carbon technologies are “caught between several stools”</p>

	Inclusion of digestate in the Draft Norms and Standards for the manufacture and applicability of organic compost	Not included	Inclusion of digestate in the Draft Norms and Standards for the manufacture and applicability of organic compost	Awaiting completion of other relevant work.		
Output 2.3 Biogas license process streamlined	Norms and standards developed for biogas at DEA	No norms and standards for biogas	1 set of norms and standards for biogas	Combined with 2.1. and 2.2.		It was jointly agreed (PSC meeting 4 th March 2019 to combine those outputs
Output 2.4 Regulatory framework on access to the grid by small to medium scale biogas projects developed	Regulatory framework developed for < 1MW biogas projects	No clear policy or regulatory framework on grid connection < 1MW	Clear policy and regulatory framework on grid connection < 1MW			It was jointly agreed (PSC meeting 4 th March 2019 to combine those outputs

Project Component 3 – Technology demonstration

<p>Outcome 3 Technical feasibility and commercial viability of waste-to-energy technologies demonstrated</p>	<p>No. of new biogas projects supported by GEF project at SMMEs</p> <p>Amount of MW installed</p> <p>Volume of investment mobilised for biogas projects</p> <p>Tonnes of CO₂eq avoided</p>	<p>No new SMME biogas projects</p> <p>0 MW</p> <p>No co-finance</p> <p>No avoided emissions related to projects</p>	<p>5 new projects</p> <p>3.7 MW installed</p> <p>18m USD</p> <p>1 Mio tCO₂eq avoided</p>		<p>MS</p>	<p>Although none of those projects was operational during, the planned installed capacity was almost achieved (4,3 MW el and 1,96 MW thermal) and some plants have been running for some time and one project was ready to start¹⁰</p> <p>The issues faced while supporting those 5 projects and the support given by WtE project to developers, owners and FIs is definitely huge learning experience. The documents (guidebooks, decision making tool, success conditions, Best Practice Manual) will support future project-Judging from the learnings from the failure the Outcome of this component can be rated moderately satisfactory</p>
<p>Output 3.1 Detailed feasibility studies of selected 5 demonstration projects are conducted</p>	<p>No. of bankable feasibility studies completed</p>	<p>0</p>	<p>5 (including gender dimensions)</p>	<p>This was included as prerequisite for qualification as demonstration project on call 1 and 2. 13 studies conducted</p>	<p>S</p>	<p>All potential projects that asked for support from WtE had to do a detailed feasibility study. All studies are well prepared and available.</p> <p>So this target was overachieved by far with 13 studies done on different projects</p>
<p>Output 3.2 Five (5) integrated biogas demonstration projects implemented to achieve at least 3MW installed capacity</p>	<p>Number of biogas projects implemented with support from GEF</p>	<p>No biogas projects implemented</p>	<p>5 projects implemented with direct support from GEF.</p>	<p>13 projects identified – 5 contracted; 2 complete and commissioned; one under construction. 2 cancelled (one due to delays and the other</p>	<p>MU</p>	<p>Out of 13 identified projects 5 have been contracted and supported with funds and technical inputs.</p> <p>Namely:</p> <ul style="list-style-type: none"> • Cavalier – CHP • Tongaat Hulett (Later transferred to Barloworld Ingrain) • Midlands - CHP

¹⁰ While report writing (September 2023) Limpopo plant was already fully functioning.

	<p>Number of systems providing bio-CNG</p> <p>Installed capacity of new organic waste to energy projects (MW)</p> <p>Annual energy generated (MWh)</p> <p>Tonnes of bio-CNG produced</p>	<p>No bio-CNG Projects</p> <p>0 installed</p> <p>0MWh</p> <p>0 tonnes/day</p>	<p>2 bio-CNG projects developed</p> <p>Installed capacity of 3.7 MW (eq)</p> <p>22,500 MWh (eq)</p> <p>4 tonnes per day</p>	<p>changed ownership</p> <p>2 CNG projects contracted – 1 dropped out; the other cancelled due to delays</p> <p>The installed capacity then was 360kW and the contracted was 9770kW which exceeded the target of 3MW under Demonstration Projects</p> <p>0</p> <p>0</p>	<ul style="list-style-type: none"> • Limpopo dairies (not yet fully commissioned) – direct biogas to heat • Likhanyiso (recently cancelled) – Bio-CNG <p>During TE mission none of the visited plants was operational and did produce Biogas. Limpopo started to fill its lagoon type digester just the day when ET arrived, is currently under commissioning and its capacity has been increased to 1,500kW. It is most likely functioning by now and producing the planned capacity of Biogas</p> <p>Cavalier and Midlands Biogas Project have been decommissioned due to a legal dispute between the Cavalier Abattoir owner/off-taker of power and heat from the project developer (iBert), and there was a technology failure at Midlands Biogas Project. Both plants operated around of one year. Likhanyiso bio-CNG was cancelled after UNIDO commissioned an assessment of the current status of the plant that revealed that it would not be completed with the Project period, due to delays in completion of construction. Talbot & Talbot as the project developer (contracted party) and Tongaat Hulett as the owner. The ownership was later transferred to Barloworld Ingrain which is why UNIDO parted ways with them due to contractual complications in the transfer Actual figures on indicators on annual generated energy and tonnes of biogas</p>
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						were therefore not available, but at the moment of the visit it was Zero.
Output 3.3 Demonstration projects monitored, evaluated and showcased.	Performance monitoring, evaluation reports on supported project Case studies on each GEF	No dissemination material on biogas for SMMEs No case studies	5 performance monitoring evaluation reports 5 case studies	Done for the contracted projects	MS	See explanations under 3.3. The evaluation report done by Resilient Circular did focus on the two, Cavalier and Midlands. There was also the assessment of Lukhanyiso done by Zero Waste. Other pilots were covered under the Best Practice Manual which reviewed all the projects and extracted lessons learned
Output 3.4 Best practice manual developed and widely disseminated	Best practice manual developed	No best practice manual	1 best practice manual	Done	HS	An excellent manual showing the critical steps and extracting the learnings from successful and failed projects has been prepared. “Best Practice Manual for Developing Industrial Scale Biogas Projects in South Africa” Under 4.4 “Success conditions for private sector biogas projects” was developed complementing the manual
Project Component 4– Scaling up						

<p>Outcome 4 Investment in waste-to-energy technologies promoted</p>	<p>Investment strategy developed</p> <p>No. of new projects implemented</p> <p>Portfolio of investment projects compiled and available to financiers and developers</p> <p>Financial support for biogas identified</p>	<p>No investment strategy developed</p> <p>No scale-up projects</p> <p>No portfolio of potential biogas projects</p> <p>No dedicated funding for biogas projects</p>	<p>Biogas investment strategy</p> <p>At least 4 projects installed and commissioned.</p> <p>Portfolio of at least 25 investment projects compiled and available to financiers and developers</p> <p>Dedicated financial support for biogas identified</p>			<p>Detailed reports (see underneath) including the database (excel) “Biogas GreenCape Finance Database May 2023” and the “PFAN - Assessment of Pipeline Projects” describing the identified financial support for biogas. The excellent manual showing the critical steps and extracting the learnings from successful and failed projects “Best Practice Manual for Developing Industrial Scale Biogas Projects in South Africa” complemented by “Success conditions for private sector biogas projects” will definitively be of high value for all stakeholder and future project developers and financial institutions.</p> <p>Outcomes from activity 4 will be highly valuable for project sustainability and the understanding of Biogas as important low-carbon technology.</p>
<p>Output 4.1 Investment strategy for integrated biogas developed and disseminated</p>	<p>Investment strategy developed</p>	<p>No investment strategy developed</p>	<p>Biogas investment strategy developed</p>	<p>Done and complete</p>	<p>S</p>	<p>A detailed report on “Integrated Biogas Investment Report June 2023” has been prepared by GreenCape and will help future project. This includes the database (excel) “Biogas GreenCape Finance Database May 2023”! Therefore these documents will be an important part for project sustainability.</p>

<p>Output 4.2 TA provided to realize at least 4 more investment projects (at least 6 MW)</p>	<p>No. of bankable feasibility studies</p> <p>Standardized long term feedstock supply agreement available</p> <p>No. of new scale-up biogas projects implemented</p> <p>Amount of MW installed</p>	<p>No bankable feasibility studies</p> <p>Informal/non-standardised feedstock supply agreements</p> <p>No scale-up projects implemented</p> <p>0 MW installed</p>	<p>4 bankable feasibility studies (including gender dimensions)</p> <p>Standardized long term feedstock supply agreement developed</p> <p>At least 4 projects installed and commissioned.</p> <p>At least 6 MW installed</p>	<p>4 assessments completed</p> <p>Combined into the Biogas Investment Decision-Making Tool and Waste-Streams Characterisation outcome</p> <p>4 projects commissioned</p> <p>14,38 MW commissioned</p>	<p>S</p>	<p>This is included in Output 1.3 (see there) Publications available, the final brochure also highlights Best Practices. SABIA webpage is functioning and utilized by industries.</p> <p>A pipeline projects deal-book has been prepared to support future investors and project developers</p> <p>Bio2Watt Phase 2 (4MW) Riverside Piggeries (320kW) Cape Dairy (9.6MW) Spif Chicken (463kW)</p>
<p>Output 4.3 Portfolio of at least 25 investment projects compiled and disseminated</p>	<p>Portfolio of investment projects compiled and available to financiers and developers</p>	<p>No portfolio of potential biogas projects</p>	<p>Portfolio of at least 25 investment projects compiled and available to financiers and developers</p>	<p>21 projects assessed – 84% of target.</p>	<p>S</p>	<p>That information is in the “PFAN - Assessment of Pipeline Projects - Final Report” from Sept 2021 and the relevant table is included.</p> <p>This report did the bankability Assessment of 21 Biogas projects in the country, see also pipeline projects</p>

<p>Output4.4 Technical support to design financial support</p>	<p>Financial support for biogas identified</p> <p>Quantity (USD) of funding identified</p>	<p>No dedicated funding for biogas</p> <p>No dedicated funds for biogas</p>	<p>Dedicated financial support for biogas identified</p> <p>USD 100m of funding identified</p>	<p>Incorporated into the Investment Strategy - complete</p>	<p>S</p>	<p>This information is included in “Integrated Biogas Investment Report June 2023”, see Output 4.1.</p>
<p>Output4.5 National biogas investment forum organized regularly</p>	<p>No. of national biogas investment fora</p>	<p>No national biogas investment fora</p>	<p>2 national biogas investment fora organised (including main event on gender dimensions of biogas; gender balance of speakers at the event)</p>	<p>2 National Biogas Investment forums completed</p>	<p>S</p>	<p>“Report Investors Forum August 2019_Final” prepared by SABIA. The 4th SABIA National Biogas Conference 2019 was conducted with support from UNIDO on 14 – 16th August 2019 with more than 150 registered delegates over the 3 days</p>

	Evaluation criteria	Definition	Rating
A	Progress to impact	A strong platform to promote Biogas has been established through SABIA and valuable knowledge products have been created. The project is contributing both directly and indirectly to CO2/GHG reduction, due to circumstance beyond the projects control the contribution on GHG reductions is below the targeted numbers.	4
B	Project design		
1	<i>Overall design</i>	Well-defined and appropriate design, as evident through the clear and detailed project document. Design fitted to the actual needs of the country in 2016 and still fits -with minor amendments to actual needs	5
2	<i>Logframe</i>	Clear LF, with appropriate number of indicators and fitted to the needs at design stage, adapted – jointly agreed in PSC meetings - to actual needs.	5
C	Project performance		
1	<i>Relevance</i>	Highly relevant to national priorities, to the work of UNIDO and the GEF, and key beneficiaries. Much needed to support awareness creation and to promote WtE as low carbon technology in the country, with the minor shortcoming that no government entity is taking up leading role	5
2	<i>Coherence</i>	The project outputs and activities are in line with South African Government priorities as well as with UNIDOs and GEFs focus on SDG 9 and 7 and GHG reduction. But it is still not fully clear where to anchor WtE!	5
3	<i>Effectiveness</i>	Most output targets achieved or exceeded, substantial progress towards most outcomes. For Output 3.3 none of the supported 5 projects was operational during, but the planned installed capacity was almost achieved and some plants have been running for some time and one project was ready to start. It has supported private sector and households towards GHG reduction	4
4	<i>Efficiency</i>	The project efficiency is rated moderately satisfactory on account of the high number of demonstration project realized in different industries (even with small rural communities and households) and the high number of experts trained and the lessons learned (converted into valuable knowledge products).	4
5	<i>Sustainability of benefits</i>	Project structure and design is already supporting WtE implementations after project completion. SABIA (platform for Biogas) has been given a voice. Industries have understood the business case of WtE (use of Biomethane and Digestate) and will continue to implement after the project end. Research has been triggered and opened funds for Universities which showed high interest for further research and to develop WtE curricula	5
D	Cross-cutting performance criteria		
1	<i>Gender mainstreaming</i>	A gender assessment study was conducted, but not much outcome visible. The objective of female participation (30%) has been achieved. Females benefitted especially from installation and training on domestic applications. a greater focus should have been placed on integrating gender mainstreaming into the various components of the project	4
2	<i>M&E design</i>	M&E design including the PLF with indicators at outcome level and M&E system was done well and was jointly adapted to the amended project plans. Feasible indicators are provided for all planned outputs.	6
	<i>M & E implementation</i>	Project had a functioning M&E system, all activities were monitored accordingly, minutes and attendance sheets available. PMU could share feasible calculations for CO2/GHG reductions or saving calculations for (Methan mitigation, replacement of chemical fertilizer) and the actual report on finance and co-finance only after the TE visit. An was not available and the GEF tracking was not	4

	Evaluation criteria	Definition	Rating
		regularly updated as the responsibility for this calculation was not defined (PMU or HQ). Mid-term review has been conducted as planned and most recommendations incorporated	
3	<i>Results-based management (RBM)</i>	Project Progress update and Action Plans were used for planning and corrective actions and supported decision making. PSC meeting conducted regularly to track the results	5
E	Performance of partners		
1	UNIDO	Well-regarded by National Counterparts and stakeholder, providing valued technical inputs and financial support. UNIDO reputation supported implementations in industries, access to finance and research work conducted by universities. Stakeholders raised issue with contracting/follow ups on deliverables	5
2	<i>National counterparts</i>	Government stakeholders played a role in the project decision-making and supported project implementation. DFFE played a very active in chairing the PSC. HR support for PMU as mentioned in endorsement document did not materialize	5
3	<i>Donor</i>	Limited inputs, but highly visible support during project initial stages and funds provided on schedule.	5
G	Environmental and Social Safeguards		
1	Environmental Safeguards	Investment in WtE was promoted therefore diverting organic waste from landfill sites. Targets were set for GHG reduction for each demonstration project. Through WtE, industrial entities can harness energy from their own waste streams and engage in collaborative initiatives with agricultural stakeholders within the context of a circular economy framework.	5
2	Social Safeguards, Disability and Human Rights	WtE has supported access to cost-effective, dependable, environmentally sustainable, and contemporary energy sources for households. WtE also can be acknowledged for its capacity to reduce the consumption of fossil fuels and furnishing a clean electricity source that can be stored and used when needed. This has not only a very positive impact on emission reduction (replacing coal or wood fires), but is also beneficial for social and health	5
F	Overall assessment	Even though none of the 5 demonstration plants was fully functioning during TE visit, WtE has not only proven the high value of digestate (to be used from local households, farmers up to mine rehabilitation), but also changed the view point on biogas projects as such towards environmentally sound resource management	4

Annex 4: List of Documentation Reviewed

1. **Project Document endorsement 130310**, (UNIDO GEF-5 South Africa 5704 CEO Endorsement re-submission_signed) signed 17th Nov 2015
2. **Unido open source data**: <https://open.unido.org/projects/ZA/projects/130310>
3. **Annual Project Reports (PIR) 2017 -2022**
4. **Project Steering Committee Meetings (2017 – 2023)**. Minutes from 11 meetings and corresponding presentations (progress reports for PSC.ppt)
5. **Supporting Documents**; WtE Biogas Project Launch Report, Feb 2017, Success conditions for private sector biogas projects in SA by GreenCape, Inception and Gender assessment report
Co-finance commitment from DEA (DFFE), DSBD, Eastern Cape Economical affairs Department, IDC, UNIVEN, GIZ cooperation
6. **Dissemination material**:
Video “Advancing biogas in South Africa”:
https://www.youtube.com/watch?v=Y_TR6C_HDPw
SABIA website (<https://sabia.org.za/southern-african-biogas-industry-association-sabia>)

Component 1 – Capacity building and technology support system

Sabia business plan, presentations and webpage;
Waste stream characterization (UNISA 2023)
decision making tool and manual; calibration report
(by Resilient Circular Sept 2022)

Biogas Guidebook 2-12-21; Operators Manual_final draft

Component 2 – Biogas market development and regulatory framework

“South Africa National Standard_Domestic and Commercial use of Biogas_- Draft”
“South Africa National Standard_The handling and storage of Biogas_- Draft
respective training material

Component 3 – Technology demonstration

Lukhanyiso bio-CNG UNIDO 1st Progress Report 2020 051120 and technical report by ZeroWaste technologies

Best Practice Manual_UNIDO_Comments Addressed, by Gamuchirai

Component 4: Scaling up

Integrated Biogas Investment Report June 2023, by GreenCape

Success conditions for private sector biogas projects, by GreenCapeGreenCape 2018

Component 5: Monitoring and Evaluation

Final MTR Report - Unido Biogas Project by Gcobane Quvile, Sept 2019

Quarterly DFFE (DEA) reports

GEF tracking tool

Grant and Co-financing data for WtE, Co- financing total, July 2022

Evaluation information:

- UNIDO Evaluation Policy (May 2015)
- UNIDO gender policy. April 2009
- DAC Evaluation Quality Standards (2006)
- DAC Glossary of Key Terms in Evaluation and Results Based Management (2002)
- Project Evaluation template_2023_08_01

Annex 5: Participants at preliminary findings presentation

Presentation of Preliminary findings at DFFE		31/082023 - 13:15 - 14:15
Name	Designation	Organization/ industrial unit
Norman Maiwashe	Professor	ARC
Leanne Richards	Director	Department of Forestry Fisheries and Environment (DFFE)
Jenitha Badul	Deputy Director	Department of Forestry Fisheries and Environment (DFFE)
Elizabeth Ntoyi	Assistant Director	Department of Forestry Fisheries and Environment (DFFE)
Lebogang Mosenthal (partially)	Project Manager	Department of Mineral Resources and Energy (DMRE)
Nokwazi Moyo	National Project Manager	UNIDO
Caterina Bianco (partially)	Project Associate Assistant HQ	UNIDO
Ndivhuho Tshikovhi	Project Associate HQ	UNIDO
Gordon Ayres	Secretary General	Southern African Biogas Industry Association - SABIA
Patricia Makhubele	SABIA Programme Manager	UNIDO/SABIA

Annex 6: List of Stakeholders Consulted

Name	Designation	Organization/ industrial unit	Date/Time
Lodewijk Nell	Director	Brundtland Consulting	21/08/2023 - 9:15-9:50
Leanne Richards	Director	Department of Forestry Fisheries and Environment (DFFE)	21/08/2023 - 10:20-12:50
Jenitha Badul	Deputy Director	Department of Forestry Fisheries and Environment (DFFE)	21/08/2023 - 10:20-12:50
Elizabeth Ntoyi	Assistant Director	Department of Forestry Fisheries and Environment (DFFE)	21/08/2023 - 10:20-12:50
Lebogang Mosenthal	Project Manager	Department of Mineral Resources and Energy (DMRE)	21/08/2023 - 13:06- 14:10
Jason Gifford	Director	Logical Waste	22/08/2023- 9:00-10:00
Darren Grobler	Farm Manager	Riverside Piggery/ Logical Waste	22/08/2023- 9:00-10:00
Tim Fischer	Process Engineer	SPIF Chicken	22/08/2023- 12:22-13:40
Jan Engelbrecht	Contractor	WEC Engineers/ SPIF Chicken	22/08/2023- 12:22-13:40
Andrew Teller	Engineer	Limpopo Dairies	23/08/2023. 10:11- 12:43
Trevor Mc Creadie	Contractor	Limpopo Dairies	23/08/2023. 10:11- 12:43
Tobias Fourie	Director	Limpopo Dairies	23/08/2023. 10:11- 12:43
David Tinarwo	Lecturer	University of Venda	23/08/2023. 14:38- 16:08
Lalumbe Hakhakhi	Intern	University of Venda	23/08/2023. 14:38- 16:08
Joseph Francis	Lecturer	University of Venda	23/08/2023. 14:38- 16:08
Jethro Zuwarimwe	Lecturer	University of Venda	23/08/2023. 14:38- 16:11
Dumisani	"Digester owner"	University of Venda - Household/Domestic digester recipient's	24/08/2023. 09:12- 15:17
Robert Marongwa	Trainee	University of Venda - Household/Domestic digester recipient's	24/08/2023. 09:12- 15:17
David Maja	"Digester owner"	University of Venda - Household/Domestic digester recipient's	24/08/2023. 09:12- 15:17
Sam Motau	"Project Co-ordinator"	Tshwane/ DBSA waste to Energy Bronkhorstspuit project	25/08/2023. 14:02-14:40
Glen Thompson	Accountant	Bio2WATT	25/08/2023- 15:13 - 16:45

Daniel Moshodi	Member - Likhanyiso Advisory Committee	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Martha Pepile	Member - Likhanyiso Advisory Committee	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Meshack Molelekoa	Member - Likhanyiso Advisory Committee	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Zolile Manqutu	Likhanyiso Board Member	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Themba Mhlombeni	Likhanyiso Board Member	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Sipho Busawe	Member - Likhanyiso Advisory Committee	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Vusumzi Mnisi	Member - Likhanyiso Advisory Committee	Likhanyiso Food and Energy Centre	28/08/2023- 10:12-11:42
Helen Drummond	Ex Deputy Dean - Centre for Applied Radiation Science	North West University (NWU)	29/08/2023- 09:37
Rodney Medupe	Deputy Dean- Teaching and Learning	North West University (NWU)	29/08/2023- 09:38
Mandla Myeza	Safety, Health and Environment Specialist	North West University (NWU)	29/08/2023- 09:39
Pieter Van Heerden	Facilities Manager	North West University (NWU)	29/08/2023- 09:40
Hannes Lombard	Farm Manager	North West University (NWU)	29/08/2023- 09:41
Bongani Dlamini	Facilities Space Management	North West University (NWU)	29/08/2023- 09:42
Jack Radmore	Energy Program Manager	GreenCape	29/08/2023-16:00-16:45
Lauren Basson	Chief Knowledge Officer	GreenCape	29/08/2023-16:00-16:45
Mike Mulcahy	Chief Executive Officer	GreenCape	29/08/2023-16:00-16:45
Gordon Ayres	Secretary General	Southern African Biogas Industry Association - SABIA	30/08/2023-10:03-11:13
Levy Maduse	National Programme Office	United Nations Industrial Development Organization (UNIDO)	30/08/2023-12:00-12:30
Mark Tiepelt	Director	Resilient Circular	30/08/2023- 12:30-12:45

Tonderayi Matambo	Head of the Biotechnology/Biochemical Engineering	University of South Africa (UNISA)	30/08/2023-14:00-14:43
Neal Johns	Technician	Logical Waste	30/08/2023-16:00-17:00



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