Concept Note

Upscaling biogas technology for cooking in iLembe District municipality, KwaZulu-Natal (South Africa)

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Response Identification Number: 201600001

July 2018

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Introduction

The iLembe District Municipality comprises four local municipalities, namely Mandeni, Ndwedwe, Maphumulo and KwaDukuza. Most of these local municipalities are rural, and the conditions therein might be suitable for biogas technology implementation. Khanyisa Projects[4], in collaboration with the South African National Energy Development Institute (SANEDI) piloted biogas technology implementation for cooking, lighting, heating water and other needs in Ndwedwe Local Municipality.

For the project, twenty-six households were selected according to certain requirements[5]. The requirements were as follows:

1. Each household should have two to three cows that they keep in a kraal overnight. This is to allow ease of collection of manure for ingesting into the biogas digester. A digester needs between 20 and 30 kg of manure daily to produce enough gas for a household to cook between 2 – 3 hours a day.
2. The households were also required to have a reliable source of water. Between 30 and 50 litres of water per day are required to operate a digester. Where water supply is problematic, the project could link with the rainwater-harvesting project, to render a household with livestock but no water suitable for consideration as a beneficiary of the project.

Based on the lessons learnt from the pilot study, it is proposed that the project be structured as follows:

1. The **proposal phase** in which a business case and funding issues will be addressed, drawing lessons from the pilot. This stage should also include extensive stakeholder engagements.
2. The **implementation phase.** This will involve building the biogas digesters and capacity development
3. The **operational phase.** The project beneficiaries will then be trained on how to operate and maintain the technology. This is a critical aspect of the project handover.

[4] http://khanyisapr.co.za/index.html
[5] http://www.urbanearth.co.za/articles/testing-biogas-rural-homesteads

Relationship to the country's sustainable development priorities

South Africa's climate change adaptation strategy discusses issues of trade-offs, which can be facilitated by improved understanding of the water-energy-food nexus[6]. This project clearly links in interventions such as these as it addresses the use of renewable energy resources (thus contributing to reducing South Africa's dependence on fossil fuels), whilst addressing water scarcity problems in the area, which in turn impacts food security.

Barriers to dissemination

In summary, key barriers to the technology dissemination are as follows:

1) Lack of financing – initial capital investment
2) Regulatory environment not favourable
3) Low knowledge level
4) Lack of adequate infrastructure

Preliminary Technology Targets and Ambition of Concept

The project will focus on upscaling the implementation of biogas digesters to Mandeni and Maphumulo. During the pilot phase, 26 households were targeted to test the implementation of the technology. It is envisaged that 40 biogas digester will be installed in each of the three selected municipalities (Maphumulo, Mandeni, and Ndwedwe). Therefore, 120 more households will be beneficiaries of biogas, across the three local municipalities. The project should potentially link with the rainwater harvesting project in this programme so as to accommodate those households that have cattle but do not have access to water.

Project Concept

The activities in this action plan can be divided under action categories

Action 1: Planning

- Activity 1: Development of terms of reference for external contractual parties in the project

6 https://www.environment.gov.za/sites/default/files/reports/nationalclimate_changeadaptation_strategyforcomment_nccas.pdf

- Activity 2: Identification & Assessment of sites (This will assist in checking out the feasibility of the selected site; which will minimize chances of failure for the project)
- Activity 3: Assessment of technology requirement

Action 2: Training of users and stakeholder engagement

- Activity 1: Training programme for local community
- Activity 2: Operations and maintenance

Action 3: Implementation (installation)

- Activity 1: Procurement of equipment
- Activity 2: Installation of equipment
- Activity 3: Provision of annual equipment maintenance
- Activity 4: Helpline for user queries

Action 4: Communication and outreach

- Activity 1: Terms of reference for outreach programme
- Activity 2: Identification of agencies to implement outreach
- Activity 3: Outreach implementation

Outputs

OUPUT 1: List of project partners, implementers and funders: Starting with Khanyisa Projects and SANEDI, project partners will need to be identified. Based on SANEDI's experience, funders might be identified beforehand; for projects such as this one, a proposal or business plan is usually required. In this case, the business plan and the solicitation of funds can take place in tandem.

OUTPUT 2: List of project beneficiaries: A similar approach to the pilot will be undertaken, with similar requirements as those in the pilot (see introduction). This means that the extent of the upscaling the technology will depend on how many homesteads qualify.

OUTPUT 3: Successful stakeholder engagement: To ensure buy in from the communities a series of stakeholder engagements will be undertaken. To a large extent this part of the project

should inform Outputs 1 and 2 above. For projects of this nature to succeed, extensive stakeholder engagement is critical. Following on the footsteps of the pilot study the following stakeholders will be considered:

- iLembe Enterprise development unit
- Meetings with and presentations to officials from iLembe, Ndwedwe, Mandeni and Maphumulo
- Discussions with departments of agriculture in the various local municipalities
- Meetings with ward councillors and Amakhosi

OUTPUT 4: Communication and outreach programme implemented.

OUTPUT 5: Trained builders, supervisors and technicians to undertake technical work for project implementation: This will also be a job creation exercise for local communities. The technical details to be included in the training of builders are:

- Proper site selection (40 sites per local municipality)
- Local suppliers of materials should be identified and be used where possible
- Technical supervisors identified (from the pilot project as these would have the necessary experience)
- Gas line and greywater line installation
- Testing for leaks (gas and water) and priming.

OUTPUT 6: Forty households per local municipality (Maphumulo, Mandeni and Ndwedwe): Develop detailed work plan (including costing) for building digesters at forty households per municipality. The pilot estimate the construction of a single digester at R50, 000.00, excluding the rainwater harvesting system[7].

OUTPUT 7: Operation training manuals/procedures that will be used across the board: Operational training should include how the technology is used and maintained as well as agricultural use of effluents.

[7] http://khanyisapr.co.za/index.html

Key Risks and Mitigation measures

The key risk for the technology are in ensuring that the technology is utilized to its full potential with minimal downtime. Lack of proper O&M can reduce the technology effectiveness and life span. This means that the end users and designated persons in households and public bodies are trained in an effective manner to ensure that the post-installation operations and regular maintenance is carried out with ease. To mitigate this risk, the municipal body has to ensure that users get relevant training for operating and maintaining the equipment in the long run. Inadequate or ineffective training can pose substantial risk to the operation of the equipment. In addition, the municipality has to ensure that procurement guidelines to include a provision of periodical equipment maintenance service from the suppliers. This also provides an alternative to users to have technical support in case they cannot manage the maintenance. The municipal body will also have to make provision for feedback from end users so that the users can provide feedback on the technology, on training and its relevance in maintaining the equipment and on the service level of the equipment provider. The Municipality will nevertheless also have to keep in mind the minor risks listed in project concept table.

Barriers and opportunities

Barriers:

The production potential of domestic biogas in South Africa has not yet been fully exploited. Deployment barriers include: limited awareness about opportunities for biogas applications, the initial cost of installation, lack of skilled labour for installation and operation, inadequate and intermittent government support, feedstock availability, need for consistent maintenance, behavioural and social acceptance, connection to a reliable water supply (which limits the availability of grey water), and competition from fossil fuel-based alternatives. Deployment of

biogas systems for cooking often requires subsidies to reduce the upfront cost of system installation.

Opportunities:

Social benefits

- Smoke-free and ash-free kitchen, so women and children are no longer prone to respiratory infections;
- Women are spared the burden of gathering firewood;

Environmental and health benefits

- Keeping manure and waste in a confined area and processing them in the digester reduces the amount of pollutants in the immediate environment and improves sanitation;
- Households no longer need to extract wood for cooking, which can reduce deforestation levels in the area;
- The sludge remaining after digestion is a good fertilizer that can be used to increase land productivity (and farm incomes).
- The release of methane is avoided thus contributing to climate mitigation. A single, small scale bio digester reduces between 3 and 5 tCO_2-eq./year.

Economic benefits

- Buying (fossil) fuel resources (e.g. kerosene, LPG, charcoal or fuel wood) is no longer needed
- Switching from traditional biomass resources (e.g., in developing countries) or fossil fuels (e.g. in industrialised countries) to biogas fired generation capacity improves security of energy supply (locally as well as nationally or regionally) as the feedstock can mostly be acquired locally.

Budget

The details of cost assessment for every activity is presented (in local currency) in the concept table along with the working notes for each cost assessment. In the table below, we provide and action wise overview of the concept in the local currency and also in US dollars (1 USD = 12.5 ZAR). These costs are only presented from the municipality's perspective, therefore do not include the incidental costs that other stakeholders such as the end users occur.

Action	**Total Budget ZAR**	**Total Budget USD @ 12.5**
Action 1: Planning	20,454 + 49,063 + 20,454 = 89,971	7198
Action 2: Training and stakeholder engagement	88,363 = 88,363	7069
Action 3: Implementation (installation)	6,000,000 + 15,000 = 6,015,000	481,200
Action 4: Communication and outreach	12,272 + 30,000 + 132,000 = 174,272	13,942
Total	**6,367,606**	**509,409**

Beneficiaries and Impacts

The project is estimated to target 720 beneficiaries (6 per household in 120 households). These are immediate beneficiaries. The project will have long term impact on the following:

1) ILembe District municipality will benefit by increasing access to energy in rural communities. The project will also contribute to iLembe's planned low emission and climate resilient growth path.
2) Food security will be improved, as the by-product of energy generation using biogas technology is manure, which is rich in nutrients and increases land fertility.
3) It will also contribute to boosting the local economy by sourcing supplies from local suppliers.
4) Jobs: A number of jobs will be created in the building industry

Sector	Energy						
Sub- sector	Energy generation						
Technology	Biogas (household)						
Ambition	40 biogas digester installed in each of the three selected municipalities (Maphumulo, Mandeni, and Ndwedwe). Total: 120.						
Benefits	1) Improved health and sanitation 2) Reduced deforestation and emissions reduction 3) Savings and energy security increased						
Action	**Activities**	**Responsible body**	**Time frame[8]**	**Risks & Mitigation**	**Success Criteria**	**M&I Indicators**	**Budget R**
1. Planning	Development of terms of reference for external contractual parties in the project	SANEDI, iLembe municipality	2	Comprehensiveness of the TORs Consult experts to ensure all-encompassing TORs	At least 3 applicants to the bid	Terms of reference for external contractual parties in the project developed and advertised.	20,454 WN 1
	Identification of sites	SANEDI, iLembe municipality	2	Some important sites are not included in the shortlist. This is not a major risk considering that the implementation is in a smaller pool. Local consultations will ensure suitable sites are chosen.	---	Installation sites identified	49,063 WN 2

[8] months

	Assessment of technology requirement	SANEDI, iLembe municipality	2	Wrong equipment is chosen. As biogas digester is an established technology, the risk of identifying wrong equipment is low. Consulting technical experts and private sector providers will mitigate the risk	Technology meets the requirements of end users	Type and quantity of equipment and accessories required is identified	20,454 WN 3
ACTION 1 TOTAL							**ZAR 89,971 / USD 7198**
2. Training and stakeholder engagement	Training programme for local community	SANEDI, iLembe municipality; Private equipment suppliers	2	Inadequate or ineffective training. This can pose substantial risk to the operation of the equipment. The training programme must be closely monitored by the iLembe municipality to ensure users are provided with adequate and effective training.	---	Training module for local community is designed and implemented.	88,363 WN 4
	Operations and maintenance	End users	*Og*[9]	Lack of proper O&M can reduce the technology	At least 90% of users can operate the	---	0 WN 5

[9] Ongoing

				effectiveness and life span. Ensure that users get relevant training for operating and maintaining the equipment in the long run	equipment after training At least 3/4th of the users who can handle regular maintenance issues after the training.		
ACTION 2 TOTAL							***ZAR 88,363 / 7069 USD***
3. Implementation (installation)	Procurement of equipment	SANEDI, iLembe municipality; Private equipment suppliers	2	Equipment is expensive. This is a low risk activity. Following standard procurement procedures will ensure the right equipment is procured.	---	All equipment and accessories required for installation are procured	6,000,000 R WN 6
	Installation of equipment	Private equipment suppliers	6	Additional structural changes required for installation. In general, biogas digester are not complex structures. However, installation will need to follow certain requirements to ensure sanitation. This risk is a low risk	---	Equipment is installed and ready to use at all the identified sites.	Included in procurement costs WN 6

				activity; however, inputs from private suppliers while identifying sites will bring to light an overall picture of specific installation requirements.			
	Provision of annual equipment maintenance	SANEDI, iLembe municipality; Private equipment suppliers	*Og*	Suppliers do not provide equipment maintenance service. Procurement guidelines to include a provision of periodical equipment maintenance service from the suppliers.	End users availing this service are satisfied with the annual maintenance service	Option of annual equipment maintenance is provided to end users.	15,000 WN 7
	Helpline for user queries		*Og*	Suppliers do not provide a helpline for service queries. Procurement guidelines to include a provision of helpline from the suppliers.	End users availing this service are satisfied with services provided through the helpline	A functional helpline is established for end users	
ACTION 3 TOTAL							***ZAR 6,015,000 / USD 481,200***
4. Communication & Outreach	Terms of reference for outreach programme	SANEDI, iLembe municipality; Local technical university	1	Comprehensiveness of the TORs Consult experts to ensure all-encompassing TORs	At least 3 applicants to the bid.	Terms of reference for designing and implementing outreach programme	12,272 WN 8

						developed and advertised.	
	Identification of agencies to implement outreach	SANEDI, iLembe municipality	1	Inadequate outreach agency. Following standard service procurement procedures will ensure the right agencies are identified to design and implement the out reach programme.	---	Implementing agency meeting the selection criteria identified	30,000 WN 9
	Outreach implementation	SANEDI, iLembe municipality; Private equipment suppliers; NGOs; Local stakeholders; Local technical university	*Og*	Agencies do not implement the outreach activities effectively This can pose substantial risk to technology deployment in future. Outreach implementation must be closely monitored by the iLembe municipality to ensure wide range of users are covered with an effective programme	Outreach programme reaches at least 300,000 people	Outreach programme successfully implemented	132,000 WN 10
ACTION 4 TOTAL							***ZAR 174,272 / USD 13,942***
TOTAL BUDGET							***ZAR 6,367,606 / USD 509,409***

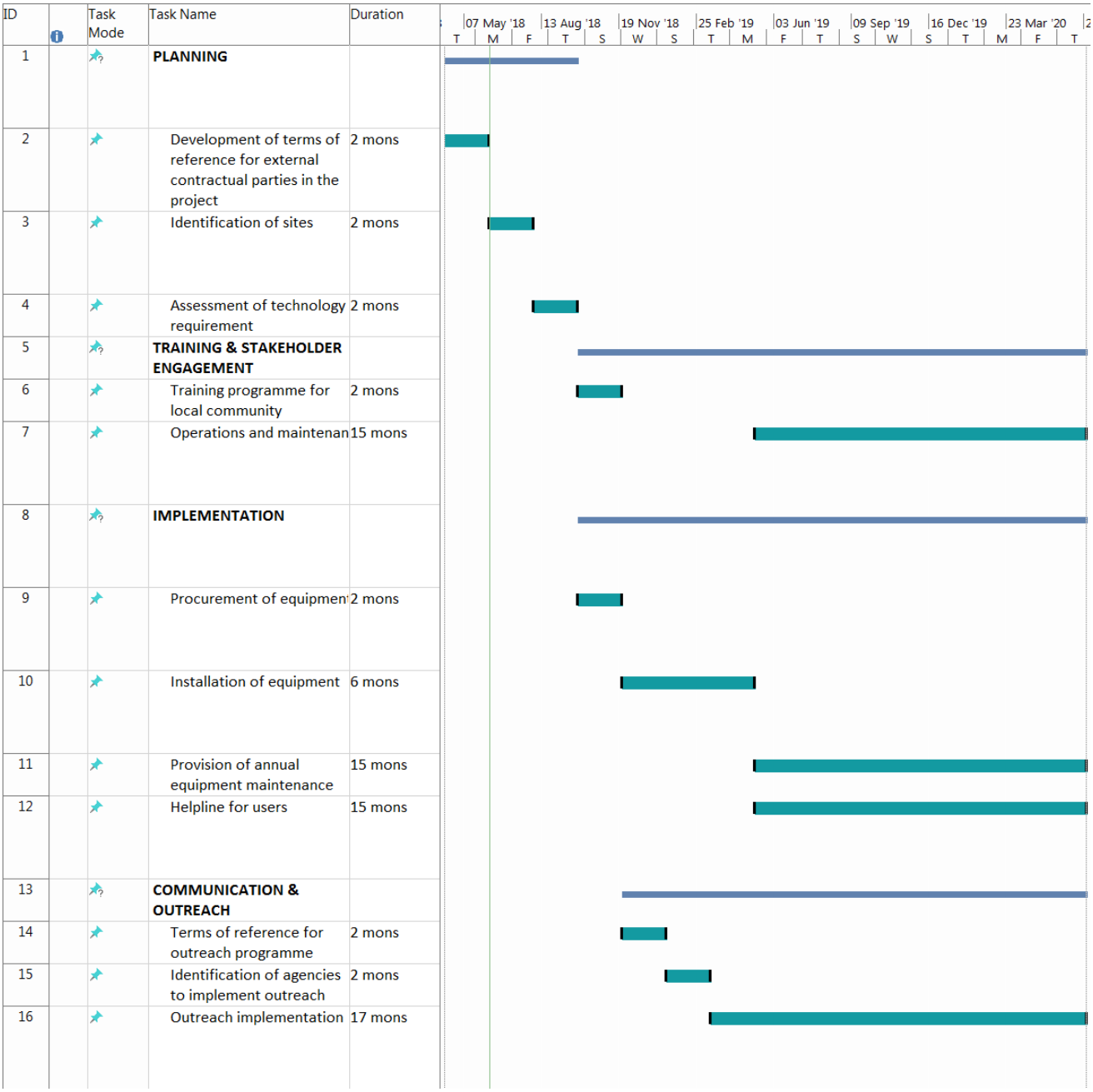
Working notes on cost and savings assumptions:

#	Cost Calculation	Assumptions	References
1	Number of persons: 5 Work Days: 3 Hourly wage: 30,000/(22*8) Total hours: 5*3*8 **Total Activity budget ≈ 20454**	Minimum wage rate is 2933 per month for workers (rounded to 3000). It is assumed that the average minimum wage for experience iLembe municipality staff is 10 times this rate i.e. 30,000 p.m. Number of working days in a month 22. Working hours per day 8.	Minimum wage rates for SA: https://mywage.co.za/main/salary/minimum-wages
2	Number of persons: 2 * 3 = 6 Travel days: 2*3 = 6 Additional Staff Days = 2 *3*2 = 12 HR Expenses = (12/22) * 30,000 = 16,363 Total trip Expenditure: 9900 * 3 = 29,700 Mapping Expenditure: 3000 approx. **Total Activity budget ≈ 16,363 + 29,700 + 3000 = 49,063**	Site visits: 3 Total distance: 125 kms per trip (based on departure from Ilembe to each municipality) Fuel efficiency: 11km/l Gasoline: 12 lit @ 50 = 600 per trip Personnel: 3000 per trip DA: 397 +128 = 525 + Mark up 100% = 1050 per trip Trip expenditure = fuel + personnel + DA = 600 + 3000 + 6*1050 = 9900	Area of iLembe: 3269 sq. km. Cost of living numbers https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa Daily Allowance http://www.sars.gov.za/Tax-Rates/Employers/Pages/Subsistence-Allowances-and-Advances.aspx
3	Number of persons: 5 Work Days: 3 Number of staff days = 5*3 = 15 HR Expense = (15/22)*30,000 **Total Activity budget ≈ 20454**	Includes tender floating time	
4	Number of trainings in each community (one full day): 2 * 3 = 6 Room rental expenditure: 6 * 1500 = 9000	Training meetings held in each municipality: 2 Room rental: 1500 per day Catering for training day: 150 per person, estimate 70 people per training	Minimum wage rates for SA: https://mywage.co.za/main/salary/minimum-wages

	Catering: 70 * 6 ≈ 63,000 Number of trainers: 2 Trainers cost: 2 * 6 * 30000/(22*8) = 16,363 **Total activity budget ≈ 88,363**	Trainers: 30000/(22*8) = 170 per hour	Cost of living numbers https://www.numbeo.com/cost-of-living/country_result.jsp?country=South+Africa
5	**Total budget ≈ 0**	As this is an activity where end users are to take action. The incidental costs for the municipality are therefore assumed to 0. The municipality will organize training for the end users to ensure they are trained enough to operate and pursue regular maintenance of the equipment. This is included in the 'training' action.	
6	Total capital expenditure Tanks: 120*50000= 6,000,000 **Total Activity budget ≈ 6,000,000 R**	Total digester requirement: 120 units (40 per municipality) If concrete domestic digester are chosen, costs are at 50,000 per unit.	Digester Prices http://www.biogassa.co.za/index.php/products/domestic-digesters
7	Number of Staff days=11 HR Expense=(11/22)*30,000 **Total Activity budget ≈ 15,000**	Provision of annual equipment maintenance and a helpline for user queries is a part of the arrangement with equipment suppliers. The expenses on behalf of the municipality are included in the staff hours spent in the development of terms of reference. A contingency expenditure of 11 staff days is kept here for receiving feedback on maintenance services/helpline from ward level representatives and NGOs.	
8	Number of persons: 3 Work Days: 3 Hourly wage: 30,000/(22*8) Total hours: 5*3*8 **Total Activity budget ≈ 12272**	Minimum wage rate is 2933 per month for workers (rounded to 3000). It is assumed that the average minimum wage for experience iLembe municipality staff is 10 times this rate i.e. 30,000 p.m. Number of working days in a month 22. Working hours per day 8.	Minimum wage rates for SA: https://mywage.co.za/main/salary/minimum-wages
9	Number of Staff days=22	Identification tasks include finalizing the proposals from shortlisted agencies including	

	HR Expense=30,000 **Total Activity budget ≈ 30,000**	negotiations among key stakeholders for roles and responsibilities for implementation of outreach activities and expert consultations.	
10	Outreach budget – 132,000 **Total Activity budget ≈ 132,000**	Depending on TORs The budget of the outreach programme will depend on the desired scale and intensity of activities within the outreach programme. This would typically depend on municipal finances. The Water Research Commission (WRC), which has committed to R880,000 finances for research and dissemination component to Vivendi's water project in 2000. Since this project would be a follow-up to the pilot biogas project, we assume that the iLembe municipality would be willing to spend up to 15% of this amount in the current time for outreach and awareness activities.	Durban Metro Water Case study https://www.wsp.org/sites/wsp.org/files/publications/af_durban.pdf

Gantt chart for activities schedule



ID	Task Mode	Task Name	Duration
1		**PLANNING**	
2		Development of terms of reference for external contractual parties in the project	2 mons
3		Identification of sites	2 mons
4		Assessment of technology requirement	2 mons
5		**TRAINING & STAKEHOLDER ENGAGEMENT**	
6		Training programme for local community	2 mons
7		Operations and maintenan	15 mons
8		**IMPLEMENTATION**	
9		Procurement of equipmen	2 mons
10		Installation of equipment	6 mons
11		Provision of annual equipment maintenance	15 mons
12		Helpline for users	15 mons
13		**COMMUNICATION & OUTREACH**	
14		Terms of reference for outreach programme	2 mons
15		Identification of agencies to implement outreach	2 mons
16		Outreach implementation	17 mons

Project Management

Objective	How will the objective be achieved?	Monitoring and Evaluation
Improve energy security and health in iLembe District Municipality	Develop efficiency in implementing the project and develop monitoring mechanisms of the use of the technology on the ground.	A regular reporting mechanism should be put in place.
Develop human capacity in installing biogas technologies	Identify suitably qualified individuals and regularly train them. The District could link with a TVET collage to consider formalising qualification from these training activities.	Keep record of trained individuals and develop a performance management system that will aim to improve skills
Remove biogas technology transfer barriers to facilitate further implementation of the technology in future	iLembe District Municipality should commission a research study to identify the localised barriers and seek means for addressing these barriers	Test the implementation of results from this exercise on the ground to test whether the removal of these technology transfer barriers actually improves technology transfer.